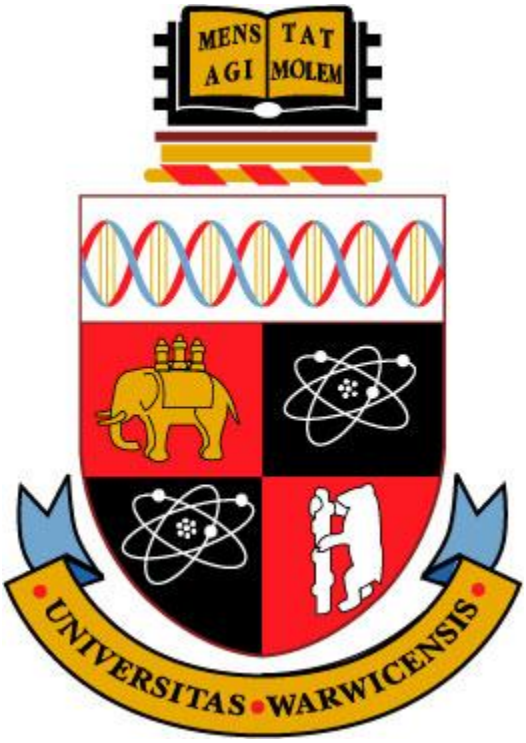
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New Product Development within Small-Medium sized Enterprises

INNOVATION REPORT

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The University of Warwick

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WMG Innovative Solutions
DRIVELINE TECHNOLOGIES
MAGAL engineering ltd
west midlands mas The manufacturing advisory service

For my Mother

Abstract

Innovation is of increasing importance for raising the productivity, competitiveness and growth potential of modern economies (BIS 2010). New products are a form of innovation and New Product Development (NPD) is the term used to describe the innovation process of commercialising a new product idea. Due to the nature of innovation small-medium sized enterprises (SMEs) produce, typically 'novel' new-to-the world offerings that provide the highest potential contribution to the economy and businesses themselves, there is an increasing emphasis on NPD within SMEs. Despite this, there is a gap between existing knowledge of the requirements of success and their application in practice. Furthermore, there is increasing recognition within the literature that the process of innovation requires on-going maintenance, disciplined audit and renewal (Leonard-Barton 1995). SMEs in particular are finding the implementation of NPD success factors challenging(Humphreys, McAdam et al. 2005; Owens 2007) and there are limited in-depth studies on how this is achieved in practice.

The research provides an understanding of the challenges SMEs face in adopting NPD success factors and develops an approach to overcome these challenges and support sustained success. The research consists of two cycles of action research involving active engagement within two independent SME contexts. The first cycle provided practical insights into challenges including factors relating to: people, process, politics and technology within SMEs. As a result the research focus was refined to consider learning as a mechanism to support the implementation and the renewal of successful NPD practices. A new model is developed, namely Logical Learning, which facilitates the development of: knowledge, skills and attitude within SMEs, for this purpose. The second cycle of action research developed a unique NPD programme that implemented the Logical Learning model within SMEs. Moreover, a comprehensive and rigorous framework for learning evaluation is developed and formally validated the significance of the model. Evidence has been generated that links the application of the model to learning within SMEs, learning to changes in behaviour and NPD practices, and changes in behaviour to organisation results.

Logical Learning was initially applied through a regional programme in the West Midlands, UK, which supported innovation within SMEs. Following success over an 18 month period, the programme competed for and won a national contract to continue to deliver this support. Therefore a nationwide roll-out is currently planned. The implementation of the model has impacted on the commercial success of SMEs, so far resulting in 8 new product introductions to market. These product innovations have generated actual sales of between £50,000 and £14 million within individual SMEs for the period 2011-2012, with businesses forecasting significant increases of over 400% in the year ahead. Collectively these SMEs have generated 93 additional jobs within the West Midlands, which contribute to economic development within the UK. Additionally the SMEs have developed NPD capabilities including the implementation of more formalised approaches and effective resource management. Moreover, these SMEs report further business development achievements including establishing partnerships with market-leading organisations, international distribution agreements and further private investment to support business growth. The research proves how learning is at the heart of these achievements and provides a new perspective on how it is facilitated, to successfully improve: knowledge, skills and attitudes and ensure SMEs are better equipped to sustain NPD success.

Acknowledgements

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Additionally, I would like to acknowledge the financial support provided by the EPSRC Warwick Innovative Manufacturing Research Centre (EP/G049971/1).

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Declaration

I confirm that the work contained in this submission is my own unless otherwise stated.

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Jennifer N. Udeh

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1 Introduction

The overall purpose of this research was to demonstrate innovation in the application of knowledge within an engineering business. The scope of this research is New Product Development (NPD) within Small-Medium sized Enterprises (SMEs) and the theme is learning and capability development to support sustained NPD success.

New Product Development (NPD) is the term used to describe the innovation process that results in the commercialisation of a new product. Innovation is of increasing importance as it contributes to the productivity, competitiveness and growth potential of modern economies (BIS 2010). Between 2000-2007, investment in innovation was responsible for two-thirds of the UK's private sector labour productivity growth, increasing the productivity by an average of 1.8 per cent per year (NESTA 2009). This contribution was largely due to improvements relating to the innovation process within businesses.

For businesses, the value of innovation is in the commercial opportunities that come from new and improved products and services (BIS and NESTA 2011). Innovation has also been linked to supporting business growth (NESTA 2009). During 2006-2008, 20 per cent of turnover for all businesses came from product innovation. The share of UK businesses with a product innovation also increased for the same period compared to 2004-2006, showing that more businesses are engaging in innovation activities.

Novel, new-to-the-world offerings provide the highest potential contribution of all the innovation types (Annacchino 2007). Therefore increasing numbers of businesses are engaging in this type of innovation. BIS (2010) report that within the periods 2006-2008, nearly 50 per cent of product innovations within innovation active businesses were 'leading edge or novel'. Small-medium sized enterprises (SME) are typically associated with this type of innovation due to their entrepreneurial characteristics. However, the practice of innovation within SMEs is also challenging. There is a gap between existing knowledge of the success factors for innovation and their adoption in

practice (Humphreys, McAdam et al. 2005; Owens 2007). Furthermore SMEs are failing to achieve sustained NPD success.

This research began within an SME, namely Magal Engineering Limited, who sought to implement improvements to their approach to NPD in order to sustain success. Hence, the initial objective of the research was to understand and overcome the challenges the SME faced in adopting NPD success factors.

Two cycles of action research were conducted and are described in this report; the first cycle addresses the initial objective and provides practical insights into the organisational challenges the SME (Magal Engineering Limited) faced in adopting critical NPD success factors and sustaining success. As a result, the research question was re-framed to consider learning within the SME as an appropriate approach to developing the understanding, capabilities and commitment necessary to overcome organisational challenges, and ensure the successful implementation of good NPD practices. The Logical Learning model was developed and defined as an appropriate approach for learning within the SME. The model captured existing knowledge and insights of good NPD practices and directed implementation efforts.

The initial outcomes led to the development of a further objective, to apply and validate the Logical Learning model as an approach for learning to support the implementation of good NPD practice and sustained NPD success within any SMEs. This was achieved during the second cycle of action research. Logical Learning was implemented through a regional programme that was developed in the West Midlands, UK to support innovation within SMEs. The regional programme has been successfully implemented and the results of a rigorous evaluation demonstrate that the programme has facilitated learning within SMEs. Moreover, this learning has impacted NPD practices and organisational results within participant SMEs and ensured they are better equipped to sustain NPD success. In October 2011, the programme was included in a winning bid to deliver innovation support nationally and therefore a national roll-out is currently planned.

1.1 The Research Question and Objectives

The research question is defined as follows:

How is existing knowledge of the requirements of successful NPD translated into practice within SMEs?

To this end three research objectives (RO) are defined:

RO1. To develop an understanding of the organisational challenges in implementing NPD success factors and sustaining good practice, within an SME context.

RO2. To develop a mechanism that overcomes these challenges and translates existing knowledge of success factors into appropriate organisational practices.

RO3. To demonstrate validity and value in the application of the mechanism within an SME context.

Each research objective was addressed in turn and the results informed subsequent actions taken as illustrated in Figure 1-1 Research Outputs and Achievements. The key outputs and achievements are discussed further in this report.

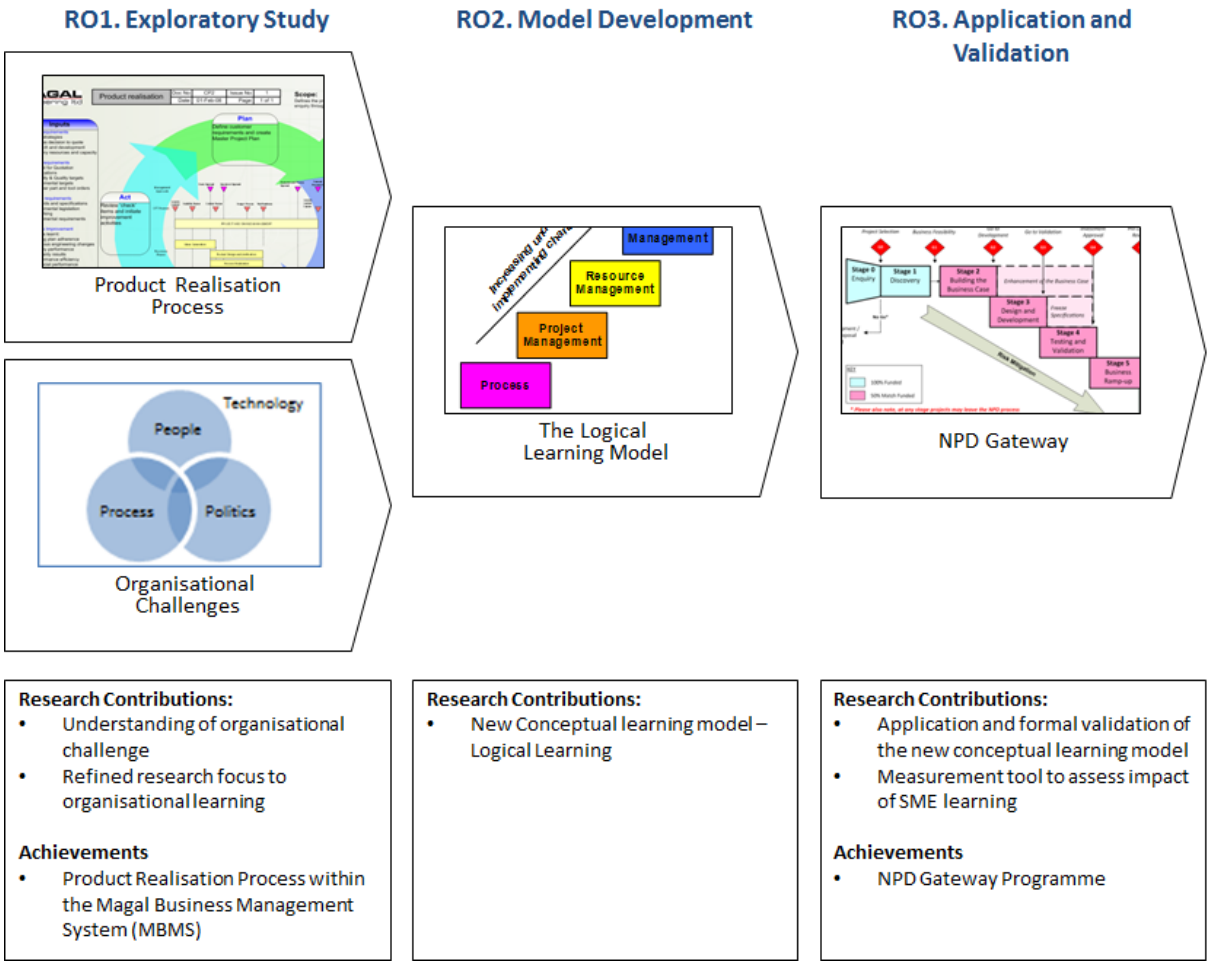


Figure 1-1 Research Outputs and Achievements

1.2 The Research Portfolio

This innovation report brings together the complete journey of actions and research that have resulted in the development and application of the Logical Learning model. This journey has made a significant contribution to knowledge and practice. This report represents the final submission in the research portfolio that consists of six submissions in total. The purpose and key outcomes of each submission within the portfolio are illustrated in Figure 1-2 Research portfolio map and key outcomes. It is suggested that the reader begins by reading the innovation report and subsequently follows the reading guide illustrated in Figure 1-3 Suggested Reading Order.

1. Introduction to NPD

Purpose: Review of Literature surrounding the research focus: NPD within SMEs

Abbreviations:

NPD	New product development
SME	Small-medium sized enterprise
ISO	International organisation for standardisation
APMS	Advances in production and management systems
POMS	Production operations and management systems
IMechE	Institute of mechanical engineering
IET	The institute of engineering and technology

7. Personal Profile

Purpose: Describe personal learning and development of engineering doctorate competencies

2. Development of NPD approach within an SME

Purpose: Develop knowledge of the challenges SMEs face in implementing NPD success factors

Achievements:

Contribution within Magal Engineering Limited:
The development and implementation of the Business Management System
- NPD Process
- Project Management Strategy

Research Outcomes:
- Knowledge of organisational challenges
- Research question
- Development of an new conceptual model

3. NPD Gateway: Process development

Purpose: Implement conceptual model within NPD Gateway

4. NPD Gateway: Process Manual

Purpose: Describe the application of the conceptual model within SMEs via NPD Gateway

5. NPD Gateway: Learning Evaluation

Purpose: Validate the application and value of the conceptual model

Achievements:

Contribution within the Manufacturing Advisory Service, West Midlands, UK:
The development and implementation of the New Product Development Gateway programme which has achieved ISO 9000:2002.

Dissemination of research to academics and practitioners:
- APMS Conference, Bordeaux, France, September 2009
- PDMA Conference, California, USA, October 2009
- POMS Conference, Vancouver, Canada, May 2010
- IMechE Lecture, London, UK, June 2010
- IET Prestigious Sir Alan Veale Lecture, Coventry, UK, November 2010
- MAS-WM NPD Gateway Showcase, Coventry, UK, April 2011

Research Outcomes:
- Application and validation of the conceptual model

6. Innovation Report

Purpose: Tell the research story, including: research methodology, development and application of the model, significance and validity of the research contributions.

Achievements:

Complete description of the development application and significance of the model

Research Outcomes:
- Identification of the research contributions to knowledge and practice
- Validation of the research

Figure 1-2 Research portfolio map and key outcomes

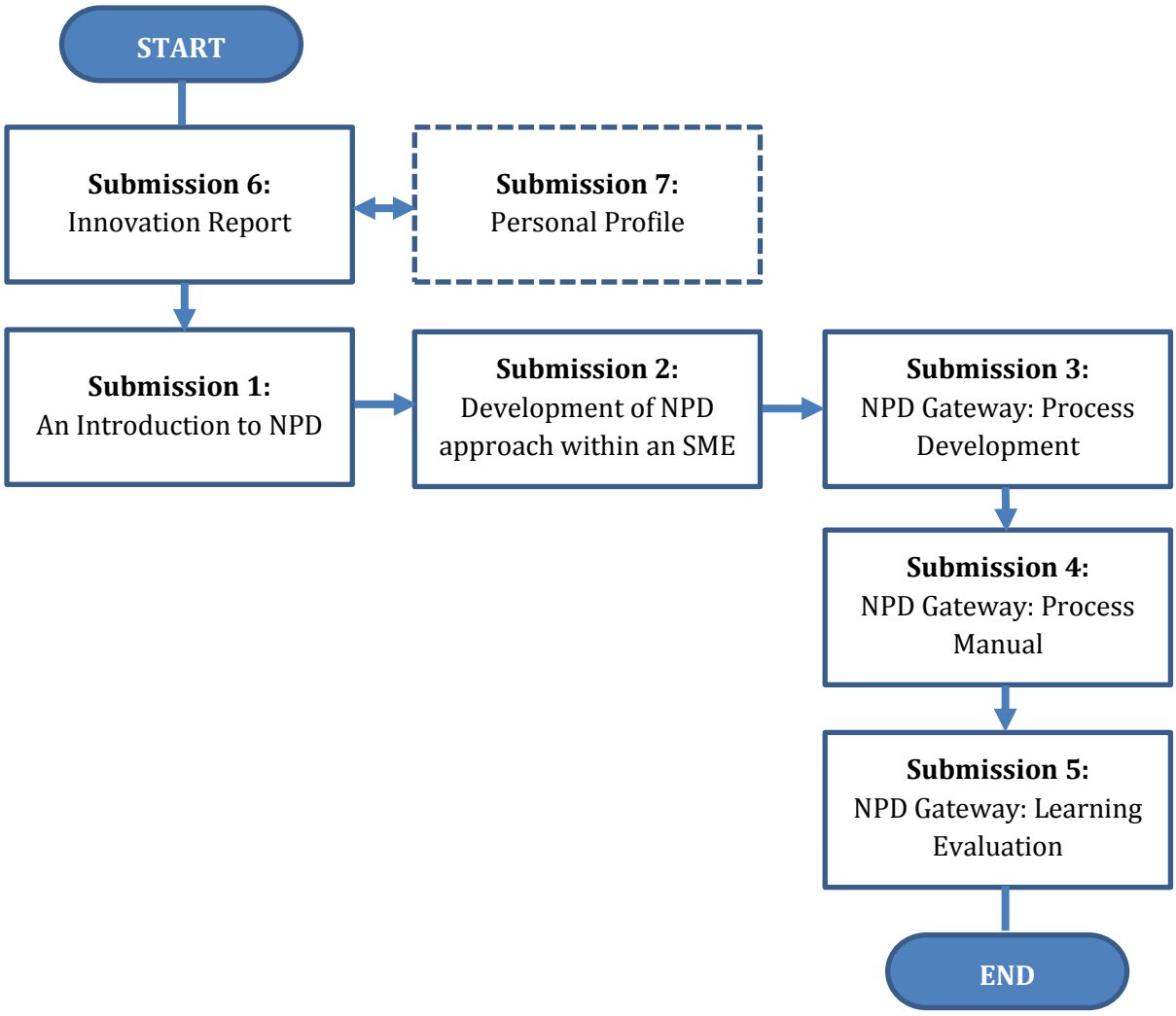


Figure 1-3 Suggested Reading Order

1.3 Structure of the Innovation Report

There are nine chapters within this report:

Chapter 2 provides a summary a review of literature that 'set the scene' by providing an introduction to New Product Development (NPD) within Small-Medium sized Enterprises (SMEs). The term NPD is defined and its importance to businesses and the economy is discussed. The importance of NPD within Small-Medium sized Enterprises is established and the characteristics and capabilities of SMEs are identified.

Chapter 3 defines the methodology used to conduct this research. An action research approach is justified and the research design is identified.

Chapter 4 discusses the first stage of the research, which involved the exploratory study within Magal Engineering Limited (Magal). The study identified organisational challenges the SME faced in implementing NPD success factors. The key achievements of the study are presented and the implications this had on subsequent research efforts are determined.

The main contribution of the research is discussed in Chapter 5. A reflection of the achievements of the exploratory study within Magal and a review of literature led to the development of the Logical Learning model. The model provides a new approach that overcomes the organisational challenges facing SMEs by facilitating learning within SMEs to support the implementation of NPD success factors.

Within Chapter 6 the application of the model within a regional business support programme is discussed.

Chapter 7 discusses the validation of the model. The results of a learning evaluation are presented. Evidence has been generated that the application of the model to learning within SMEs, learning to changes in behaviour and NPD practices, and changes in behaviour to organisational results.

A final reflection on the research outcomes is discussed in Chapter 8 and finally Chapter 9 presents the conclusions of the research, which highlights the key contributions of the research.

2 Review of Literature

The term 'new product development' (NPD) is defined and its importance to businesses and the economy established. Existing knowledge of how new products are developed and the structures and processes that lead to success are identified. Finally, the characteristics of NPD within small-medium sized enterprises (SMEs) are identified and the implication organisational size has on the capability to innovate is discussed.

2.1 New Product Development

New product development (NPD) is a term that refers to the complete business process of developing and commercialisation a new product idea. It is a multi-disciplinary process (Clark and Wheelwright 1993) involving most functions within a business. The functions must collaboratively implement appropriate NPD strategies and tactics (Cooper 2001) in order to ensure success. Strategies refer to activities involved in determining which direction an organisation's NPD efforts should follow. It answers questions such as: what products should be developed and what marketplace should be targeted? Tactics refer to the tools by which the strategy is implemented and answers questions such as: how should NPD be undertaken and what capabilities are required to bring the new product to market?

Although there is no common definition for NPD, the Product Development and Management Association (PDMA) offer a comprehensive definition which aids an understanding of the breath of the business process:

"[New product development is] *the overall process of strategy, organisation, concept generation, product and marketing plan creation and evolution, and commercialisation of a new product"* (www.pdma.org)

However it is the strong relationship between NPD and innovation that characterises the importance of continued research within this area. In his seminal work, Schumpeter (1934) identifies new products as one on five types of innovation, such that NPD is

considered an innovation process. This perspective is supported by NESTA (2009), who adopt the following definition of innovation as: "*the design, invention, development and/or implementation of new or altered products, services, processes, systems, organisational structures, or business models for the purposes of creating value for customers and financial returns for the firm"* (US Advisory Committee).

2.1.1 The Importance of Innovation

Innovation such as NPD within businesses is a vital ingredient in raising the productivity, competitiveness and growth potential of modern economies (BIS 2010). In the UK innovation remains a central topic for achieving economic growth, with a number of government bodies engaged in encouraging and facilitating innovation. These include: Technology Strategy Board (TSB), National Endowment for Science, Technology and the Arts (NESTA) and the UK Department for Business Innovation and Skills (BIS).

Continued investment in innovation contributes to the economy and businesses themselves. This investment generates revenues and profits that are paid out to suppliers and personnel who go on to contribute to other enterprises through purchasing goods and services (Annacchino 2007). Furthermore, retained earnings fund business growth and development, which safeguards jobs and creates employment for the good of the economy. Between 2000-2007, investment in innovation was responsible for two-thirds of the UK's private sector labour productivity growth, increasing the productivity by an average of 1.8 per cent per year (NESTA 2009). This contribution was largely due to investments in "better way of doing things" and included the broader benefits of technology advances and improved processes. Moreover, during 2006-2008, 20 per cent of turnover for all businesses came from product innovation.

Additional to the intrinsic value of innovation, its importance to businesses is driven by a number of factors. This includes: seeking competitive advantage, responding to competition and improving customer satisfaction. Each of these factors can lead to a need for changes in products, processes or business practices (BIS 2010). Figure 2-1

Determinants of innovation (percentage of strict innovators rating determinants "high"), identifies recent determinants of innovation. The most significant factors include a need to:

- Improve the quality of goods and services, due to diverse and rapid advancements in technology and changing customer requirements.
- Increase the range of goods and services, due to an increase in the speed of competitive new product being introduced to market.
- Increase value added and market share, in order to remain competitive.
- Reduce the costs per unit produced or provided, due to the increasing threat of globalisation, which has introduced the low-cost manufacturing alternative and created hypercompetitive global markets.

The latest figures show that product related factors continue to be the most frequent driver of innovation (BIS 2012), which reiterates the importance of product innovation and furthermore, reinforces a customer focused approach to innovation.

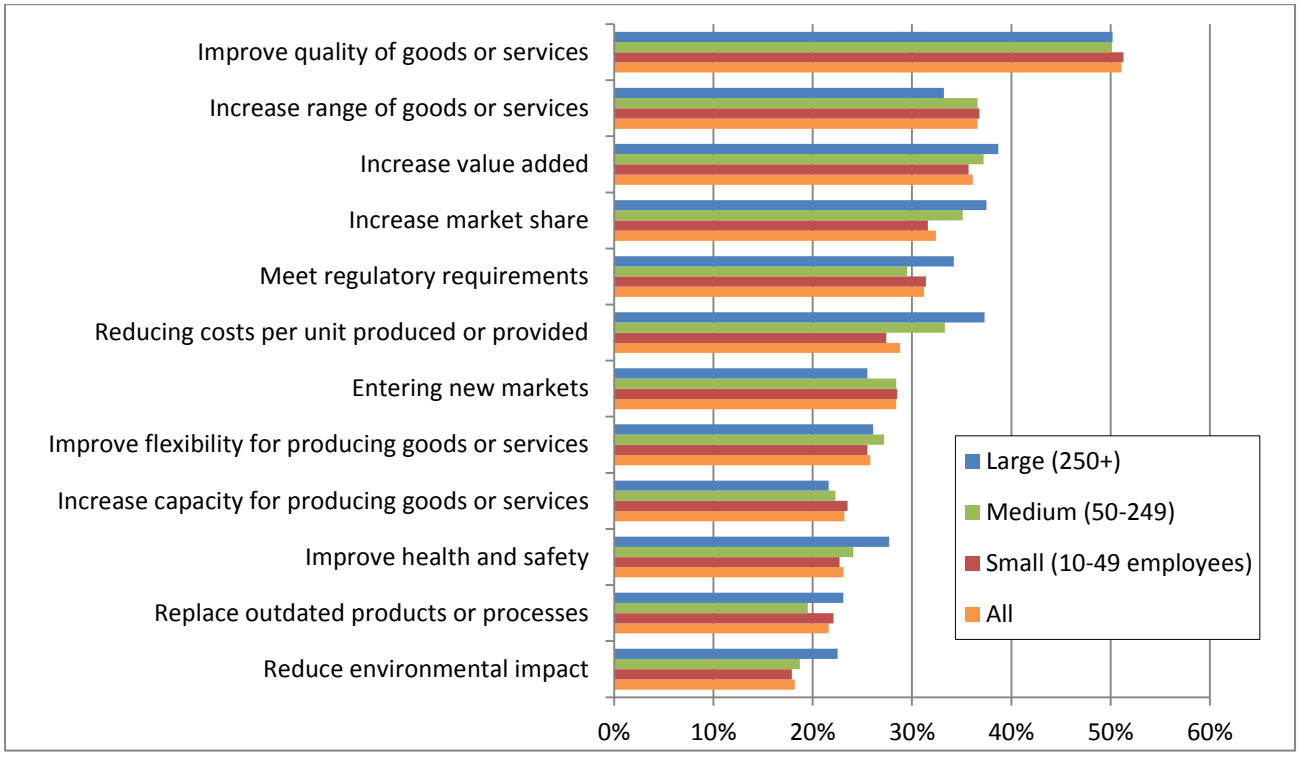


Figure 2-1 Determinants of innovation (percentage of strict innovators rating determinants "high")
Source: reproduced from BIS "UK Innovation Survey 2009" (BIS 2010)

Businesses are also experiencing pressures to innovate in order to meet regulatory requirements, which in the UK have focused on promoting innovation and particularly NPD on both a regional and national level.

The exploitation of innovative offerings such as NPD is increasingly becoming essential for sustained economic development. In a Government White Paper, "Building the knowledge driven Economy" (published by the DTI in 2008), the then Prime Minister Rt. Hon. Tony Blair, advocated the evolution of a knowledge-driven society, based on the exploitation of knowledge, skills and creativity. NPD has since been emphasised as an important stimuli within this new economic structure. It is recognised that commercial success will depend on organisations abilities to acquire and utilise knowledge and apply this to the development of new products (Trott 2008).

The UK's current government policy for innovation, as defined in 'The Innovation and Research Strategy for Growth" (BIS 2011) published on 8th December 2011, identifies a continuing focus on the development of the new knowledge economy by encouraging collaborations and knowledge-sharing to support innovation within businesses.

Evidently, the practice of NPD is increasing within businesses. The share of UK businesses with a product innovation increased during the 3 year period 2006-2008 compared with 2004 – 2006. BIS (2010) report for the period 2006-2008, product innovation represented the second highest share of innovation activity across all businesses. 24 per cent of all businesses were product innovators (Table 2-1 Percentage of enterprises who were innovative active, by firm size and type of activity, 2006-2008).

The new economic structure is also demanding that companies assess their business processes and organisation in order to sustain success. Table 2-2 Percentage of enterprises that were wider innovators, by firm size and type of activity, 2006-2008 identifies how enterprises in the UK have undertaken significant business process changes in pursuit of competitive advantage. Overall 26 per cent of all businesses adopted changes within areas including: organisation, advanced management techniques and marketing strategy. These areas all involve a business's NPD process.

Table 2-1 Percentage of enterprises who were innovative active, by firm size and type of activity, 2006-2008

Type of activity	All	Small	Medium	Large
Innovation active	58.2	57.3	62.5	61.2
Product innovator	23.9	23.0	28.5	31.5
Process innovator	12.6	12.0	15.4	18.9
Abandoned innovation projects	3.5	3.3	4.5	6.6
On-going innovation projects	5.6	5.1	8.1	9.2
Activities related to innovation	55.0	54.2	59.0	55.9

Source: reproduced from BIS "UK Innovation Survey 2009" (BIS 2010)

Table 2-2 Percentage of enterprises that were wider innovators, by firm size and type of activity, 2006-2008

Type of activity	All	Small	Medium	Large
Wider innovators	**26.5**	**24.5**	**36.5**	**39.0**
New or significantly changed corporate strategy	12.4	11.4	17.0	19.6
New management techniques	10.1	8.9	15.6	19.3
Major changes to organisational structures	16.4	14.8	23.4	27.5
Changes to marketing concepts or strategy	15.7	15.0	19.8	18.3

Source: reproduced from BIS "UK Innovation Survey 2009" (BIS 2010)

2.1.2 The Determinants of Successful New Product Development

The literature continues to advocate the implementation of a 'process approach' to ensure the success of business processes such as new product development (NPD) (Hammer 1990; Davenport 1993; Garside 1998; Raymond, Bergeron et al. 1998; Balbontin, Yazdani et al. 2000; Cooper 2005; Humphreys, McAdam et al. 2005; Mackay, Bititci et al. 2008; MacCormack, Crandall et al. 2012). This refers to the appropriate definition and structuring of the activities or tasks within a process and involves the

management of the inputs, outputs and interactions within the process. More specifically, a NPD process typically consists of three components (Castellion 2005):

1. Decision making
2. Cross-functional workflows
3. Supporting systems and practices.

The decision-making component ensures the right products are developed by the organisation in a way that provides the desired value to both the customer and the business. At the heart of the decision making component is the 'NPD Strategy' for the business. The strategy is informed by and guides decisions regarding the selection of project, the management of individual and multiple project and the organisation of the business for NPD.

Cross-functional workflows consider the information or insights needed to aid decision-making and the methods and activities required to generate this knowledge (Castellion 2005). This component begins to describe the operational features of the NPD process and the characteristics of cross-functional project teams.

Supporting systems and practices assist an organisation's NPD effort. There are a range of systems and practices that organisation can effectively use, including (Belliveau, Griffin et al. 2002):

- Tools for engineering and design, e.g. Quality Function Deployment and Computer aided design.
- Strategic tools for improving NPD performance, e.g. NPD metrics and measures.
- Tools for effective management during NPD projects, e.g. knowledge and product data management.

There is substantial body of knowledge which investigates the factors that determine successful NPD. Table 2-3 New Product Development Success Factors, identifies the most widely accepted business characteristics and practices that determine NPD success.

Table 2-3 New Product Development Success Factors

Cooper and Kleinschmidt (2007)		**Cooper (2001)**
Strategy	The company's total new product strategy	• A unique superior product: a differentiated product that delivers unique benefits and superior value to the customer. • A strong market orientation – a market-driven and customer focused new product process. • Look to the world products: an international orientation in product design, development, and target marketing. • Leveraging core competencies • Focus on products aimed at attractive markets • A well-conceived, properly executed launch and a solid marketing plan at the heart of the launch.
Process	The company's new product development process and specific activities within this process	• More predevelopment work (homework) before product development. • Sharp and early product and project definition. • Touch go/kill decision points, where projects really do get killed: better focus on results • More emphasis on completeness, consistency, and quality of execution of key tasks from the beginning to the end of the project. • Speed but not at the expense of quality • A multistage and disciplined new product process.
Organisation	The way the projects are organised	• The right organisational structure, design, and climate for NPD.
Culture	The company's internal culture and climate for innovation	
Commitment	Senior management's involvement with and commitment to new product development	• Top management support

Source: adapted from Cooper (2001) and Cooper and Kleinschmidt (2007)

Significantly, the literature establishes that the NPD success factors identified a decade ago still apply (Brown and Eisenhardt 1995; Cooper 1999; Kanter 2006).Furthermore Humphreys, McAdam et al. (2005) cite Leonard-Barton (1995) who states that the process of innovation requires on-going maintenance and renewal because the capability to innovate is much easier lost than it is to acquire. Therefore there has been an increasing emphasis on managing and sustaining the effective implementation of established success factors within businesses e.g. the investigation of process governance conducted by Cooper and Edgett (2012).

2.2 The Importance of Innovation within Small-Medium sized Enterprises

Businesses of all sizes engage in innovation, however this research project adopts a focus on the small-medium sized enterprise (SME). SME is a term predominantly used in Europe to defined businesses that have up to 250 employees. The definition includes sub-categories for micro, small and medium sized enterprises, which are defined as consisting of less than 10, 50 and 250 employees respectively (Europa 2010).

Innovation within SMEs is important because of the nature of innovation this type of business produces. The management of SMEs is often associated with entrepreneurship, which is defined as:

"the process of planning, organising, operating, and assuming the risk of a business venture" Low and MacMillan (1988) cited in Trott, 2008)

It is a practice that leads to high level innovations that are typically 'novel' new-to-the world offerings due to the nature of the opportunity and the attributes of the entrepreneur. Although all innovation contributes to businesses and the economy, 'novel' new-to-the-world offerings are significant as these provide the highest potential contribution as identified in Table 2-4 Types of product development programmes.

Evidently, businesses are recognising the significance of novel new-to-the-world product offerings to support their development and sustained success. BIS (2010)

report that within the periods 2006-2008, nearly 50 per cent of product innovations within innovative active businesses were 'leading edge or novel'.

Table 2-4 Types of product development programmes

Type of New Product	Time to Introduce	Potential Revenue Contribution to Economy	Potential Revenue Contribution to Company
New-to-the-world	Longest	Highest potential	Highest potential
New product lines	Long	High potential	High potential
Additions to existing lines	Medium	Medium potential	Medium potential
Improvements	Short	Little potential	Medium potential
Repositioning	Shortest	Little potential	Medium potential
Cost reductions	Shorter	Little potential	Medium potential

Source: Reproduced from "The pursuit of new product development" (Annacchino 2007)

In the UK an increasing number of SMEs are engaging in innovation than ever before. While the share of enterprises that are 'innovative active' tend to increase with business size, BIS (2010) report that smaller businesses are narrowing the gap with large businesses on levels of engagement across a range of innovation related behaviours.

However despite the importance of innovation within SME and an increasing focus on innovation relating to this context, there is a gap between existing knowledge of the success factors and their adoption in practice. Businesses are finding the implementation of the success factors challenging (Barclay 1992; Klein and Sorra 1996; Klein and Knight 2005). This is particularly true for SMEs (Humphreys, McAdam et al. 2005; Owens 2007).

NPD research has generally focused on large, well established enterprises and there have been relatively limited in-depth studies on how SMEs practically incorporate innovation principles and practices within their businesses (McAdam 2000; Millward and Lewis 2005). Furthermore, few authors have considered how SMEs effectively sustain the implementation of NPD success factors. It cannot be assumed that

innovation implementation principles within large enterprises are transferable to SMEs. Therefore in order to ensure sustained NPD success within SMEs there is a need to study how innovation is implemented within the constraints and characteristics of this context (Humphreys, McAdam et al. 2005).

2.2.1 Innovation Capabilities of Small and Large Enterprises

The characteristics of SMEs are different to those that exist within large enterprises. Trott (2008) established a comprehensive set of organisational requirements and capabilities that facilitate the innovation process. With consideration to the characteristics of small and large enterprises (as identified in Table 2-5 the characteristics of small and large businesses) these organisational requirements are used to provide an assessment of innovation capabilities. The assessment is illustrated Table 2-6 the potential capability of small and large businesses to adopt organisational characteristics that facilitate innovation'.

A growth orientation is associated with engagement in innovation as innovation provides a means for the development and growth of enterprise (Cox 2005; Annacchino 2007; NESTA 2009; BIS 2010). Small businesses have a moderate potential to adopt a growth orientation as some small businesses are lifestyle businesses, where the owners are more concerned with establishing a comfortable living for themselves. In contrast, large businesses are traditionally motivated by maximising the value of the company, which supports a high potential to adopt a growth orientation.

The characteristics of the organisation and management of small businesses suggest a high potential to adopt innovation capabilities including: organisational heritage and innovation experience, space for creativity, and cross-functional cooperation and coordination within organisational structure. They tend to have a more informal nature of communication, relatively less bureaucracy and a flatter management structure. This suggests an environment within a small business that is favourable to effective team working and the sharing of ideas and knowledge. This ability also provides a speed and flexibility edge over larger businesses, which are typically more bureaucratic in nature, with more formal lines of communication.

Table 2-5 the characteristics of small and large businesses

	Small Businesses		**Large Businesses**	
Typical Characteristics	High risk of failure makes organisation more focused on short-term survival (cash rather than profit). Also makes some small businesses want to grow fast to minimise risk. Diverse motivations of owners – some are 'lifestyle' owners and may focus on obtaining a comfortable living for themselves, while others may want to grow the business rapidly. Provide less formal training and recruit new staff through informal channels Able to commercialise innovations quicker, but less likely to adopt innovations.		Lower risk of failure. More influence within the marketplace and brand can be a major positive factor influencing sales. Traditionally the motivation of the owner or shareholder is to maximise the value of the company More likely to provide formal training and use formal channels to recruit new staff. Large businesses' innovation capitalises on heavy expenditure on formal Research and Development.	
	Advantages	Disadvantages	Advantages	Disadvantages
Management	• Typically a dynamic Manager • Often have strong commitment of the innovation • Quicker decision making	• Less professional • Often emotionally linked to the innovation • Can be technically rather than market focused	• Typically qualified 'professional' managers • Typically 'objectively' appraise and innovation	• Managers may be risk averse or lack dynamism
Market Position	• Potentially closer to the market • Able to focus on small market niches	• Lack market power/ influence	• Bargaining power with suppliers/more influence	• Potentially 'distant' from the market (innovate from the 'top' down)
Organisation / People	• More informal communication • Less bureaucracy • Flatter management structures	• Lack highly skilled personnel	• Able to call on specialists cross-functional resources	• Lack of internal flexibility • More formal communication and bureaucracy
Resourcing	• More likely to use R&D finance efficiently • Fewer resources invested so less likely to 'fear' failure.	• Reliant on (usually limited) internal sources of finance	• Have financial resources necessary to conduct R&D • Greater marketing resources	• Bureaucratic nature of the business may mean that it takes longer to introduce innovation

Source: adapted by the author from Storey and Greene (2010)

However, the characteristics of large businesses suggest that they are more able to adopt innovation capabilities including: vigilance and external links and commitment to technology and R&D. This refers to the business's ability to maintain awareness of the external environment in order to effectively pursue the most effective opportunity (Trott 2008).This also refers to the business's commitment to resources in terms of input from, science, technology and engineering.

Moreover, large businesses have an advantage over small businesses in that they possess the financial resources and ability to draw on specialist skills and expertise to commercialise an innovative idea. Their professionalism allows them to take a more holistic approach to innovation which considers marketing and commercial factors, therefore maintaining their awareness of the external environment. This increases their likelihood of successful innovation.

Although small businesses typically have a strong focus on technology they have limited resources, which suggest a relatively moderate capability in terms of receptivity i.e. the capability to invest in externally developed of technology. Furthermore, while small businesses are potentially closer to the market, limited marketing resources is impeding their strategy towards innovation.

However, a major advantage a small business has over a large business is the capability to accept risk. Small businesses typically have a dynamic manager who often has a strong commitment to innovation and is less likely to 'fear' failure. In contrast, large business managers tend to be risk averse, which can be attributed their high investment in R&D and the bureaucratic nature of the organisation.

In summary, both large and small businesses have the capability to innovate, however the attributes of small businesses allow them to act more entrepreneurially and engage in higher level innovation activity. This entrepreneurial tendency is hindered by a resource constraint in terms of knowledge, skills and finance. These areas represent key strengths within large organisations and support a conclusion that with regard to innovation: *"a small business enjoys a behavioural advantage whist a large business has a resource advantage"*(Storey and Greene 2010)

Table 2-6 the potential capability of small and large businesses to adopt organisational characteristics that facilitate innovation[1]

Organisational Requirements	Characterised by	Small Business Capability	Large Business Capability
Growth Orientation	A commitment to long-term growth rather than short-term profit	Moderate	High
Organisational heritage and innovation experience	Widespread recognition of the value of innovation	High	Moderate
Vigilance and external links	The ability of the organisation to be aware of its threats and opportunities	Moderate	High
Commitment to technology and R&D intensity	The willingness to invest in the long-term development of technology	Moderate	High
Acceptance of risk	The willingness to include risky opportunities in a balanced portfolio	High	Low
Cross-functional cooperation and coordination within organisational structure	Mutual respect among individual and a willingness to work together across functions	High	Moderate
Receptivity	The ability to be aware of, to identify and to take effective advantage of externally developed technology	Moderate	High
Space for creativity	An ability to manage the innovation dilemma and provides room for creativity	High	Moderate
Strategy towards innovation	Strategic planning and selection of technologies and markets	Low	High
Coordination of a diverse range of skills	Developing a marketable product requires combining a wide range of specialized knowledge.	Low	High

[1]Note: Colours indicate the potential capability of business adopting the respective organisation requirement based on the characteristics establishes in **Table 2-5 the characteristics of small and large businesses**: red refers to low capability, yellow (Y) refers to moderate capability, green (G) refers to high capability**.**

2.3 Summary of Review of Literature

New Product Development (NPD) is an innovation process and is important for sustained economic and business success. Novel, new-to-the-world NPD offerings make the highest potential contributions to businesses and the economy, and are typical of the type of innovation small-medium sized enterprises (SMEs) produce. There is an increasing emphasis on innovation and NPD within the SME context.

There is a substantial body of knowledge of the principles and practices for successful NPD. Significantly, the NPD success factors identified a decade ago still apply (Brown and Eisenhardt 1995; Cooper 1999; Kanter 2006) and continue to be reiterated within the literature. A potential reason for this is that the capability to innovate is much easier lost than in is acquired and therefore the process of innovation required on-going maintenance and renewal (Leonard-Barton 1995).

However, there is a gap between existing knowledge of the success factors and their adoption in practice and businesses are experiencing implementation challenges (Barclay 1992; Klein and Sorra 1996; Klein and Knight 2005). This is particularly true for SMEs (Humphreys, McAdam et al. 2005; Owens 2007).

NPD research has generally focused on large, well established enterprises and there are relatively limited in-depth studies on how SMEs practically incorporate the principles and practices of innovation within their businesses (McAdam 2000; Millward and Lewis 2005). Moreover, few authors have considered how SMEs effectively sustain the implementation of NPD success factors. As a result, there is a need to study how innovation is implemented within the constraints and characteristics of an SME context (Humphreys, McAdam et al. 2005) and furthermore how SMEs sustain success. Typically, SMEs are characterised as having behavioural advantages over large business which support the achievement of higher level innovations i.e. new-to-the-world, however they are typically constrained in terms of resources.

3 The Research Methodology

The action research methodology used during the research is justified and research design is defined.

3.1 Justification of the Action Research Approach

The research question and objectives required the researcher to develop an understanding of challenges within an SME, namely Magal Engineering Limited, in order to intervene and improve practice. The research purpose required a constructivist perspective that justifies an interdependent relationship between the actions of the researcher and the phenomenon under study. In contrast to other theoretical perspectives, the fundamental aim of constructivism is to "construct reality", whereas positivism explains reality and interpretativism seeks above all to understand it (Girod-Seville and Perret 2001).

A constructivist perspective was supported by an action research approach that promoted the researchers interaction within a social setting. Action research is justified in its application to this research where action is central to the research (Herr and Anderson 2005) i.e. an intervention within an SME. It further supported the purpose and objectives of the research as it focuses on practical issues with the aim of creating knowledge that is useful and contributes to improving practice.

Reason and Brandbury (2008) provide a comprehensive definition of action research which considers the existing research and thinking within the field:

"Action Research is a participatory process concerned with developing practical knowing in the pursuit of worthwhile human purposes. It seeks to bring together action and reflection, theory and practice, in participation with others, in pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities"

The authors define five characteristics of this research approach that reflect the characteristics of the design of the present research:

1. *Emergent developmental form* - good action research emerges over time in an evolutionary and developmental process. The present research process was conducted over a four year period where interpretations and the knowledge developed were strengthened as understanding increased.
2. *Practical issues* - Action research has a practical emphasis and focuses on issues which are significant to the research participants. The present research aimed to contribute to NPD practice within SMEs and therefore focuses on practical issues.
3. *Knowledge-in-action* - During action research knowledge is conceived in action and is based on the experiences of the participants. The present research was based within two SME contexts where actions provided insights and learning that have shaped the research outcomes.
4. *Participation and democracy* - Action research is participatory in that it involves groups of individuals working together through various stages of action and reflection. The present research consists of active involvement in collaborative projects within two SME contexts.
5. *Human flourishing*– action research effectively supports learning, development and practice. By considering relevant practical issues it enables the creation of practical knowledge and reflection which can guide and inspire practice. The present research demonstrates innovation in the application of knowledge within a business environment. In doing so the researcher also demonstrates the development of various competencies (refer to Submission 7 – Personal Profile). The creation of practical knowledge, learning and the development of practice are inherent in requirements and outcomes of the research.

In action research, change is the only certain object (Checkland and Holwell 1998) and the researcher is seen as an agent of change (Gray 2009). Reason and Brandbury (2008) argues that action research starts from an orientation of change 'with other' and may eventually result in changing others 'out there'. The latter was the original intent of the research methodology as conceived by Lewin, who viewed the approach as a way of

improving social behaviour and encouraging social change (Gray 2009). This research demonstrates how change has been facilitated within two SME contexts and generates knowledge that provides a new perspective of how sustained NPD success can be support within SMEs.

3.2 The Research Design

Figure 3-1 the research design, illustrates the phases of this research, from the identification of the research question through to the validation of a new model, namely Logical Learning. The model was developed to facilitate learning and the implementation of NPD success factors within SMEs to ensure sustained success.

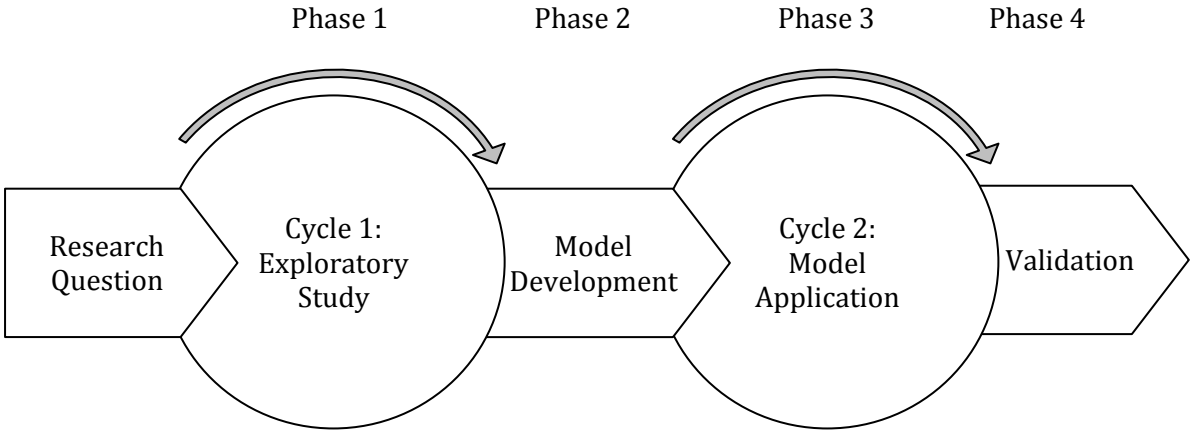


Figure 3-1 the research design

The action research cycles included an iterative process of: planning, acting, observing and reflecting (Altrichter, Kemmis et al. 2002). Two cycles have been progressed through in order to make a distinct contribution to knowledge and practice (Zuber-Skerritt and Perry 2002). Each cycle involved working groups within different SME contexts including Magal Engineering Limited (Magal) and the Manufacturing Advisory Service in the West Midlands, UK (MAS-WM). The learning developed in the reflection phase of the first cycle i.e. Magal, was transferred to planning phase of the second cycle i.e. MAS-WM. The validity of the research has been ensured by following a disciplined process of enquiry (Gray 2009), where methods data collection and interpretations

have been strengthen and revised as understanding increased. Appendix 1 Validity of the Research identifies the validity and quality of this research with consideration to five validity criteria that are linked to the five characteristics of action research identified above.

3.2.1 Action Research Cycle 1

Exploratory Study

The research question asked "How is existing knowledge of the requirements of successful NPD translated into practice within SMEs?" "How" type questions such as this are suited to exploratory case based research approaches (Yin 2003) therefore the first cycle of action research involved an exploratory study within Automotive Product Driveline Technologies, an SMEs that was part of Magal Engineering Limited. Active involvement in a NPD improvement project within the SME resulted in the development and implementation of the Magal Business Management System (MBMS). The MBMS included a new improved approach to NPD. An evaluation administered by self-completing questionnaire assessed the impact of actions and determined the value of the outcomes of the project.

Reflection of Actions and Outcomes

During the reflection phase practical insights into the challenges SMEs face in adopting NPD success factors and sustaining good practice were established. This was achieved by reflecting on actions and outcomes with consideration to data gathered from various sources including: semi-structured interviews, observations and an internal evaluation within Magal. Knowledge of: people, process, political and technology challenges were generated and lead to a refinement of the research question to a focus on organisational learning as a mechanism to support the implementation of good NPD practices within SMEs and sustained success.

Development of the Logical Learning Model

A new conceptual model - Logical Learning – was developed to facilitate learning within SMEs to support the implementation of good NPD practices and sustained success. The model captures existing knowledge of the requirements of successful NPD. It is original in its focus on NPD within SMEs and its identification of a "bottom-up" relationship between the success factors. This relationship defines incremental stages of a SMEs journey of learning and the implementation of NPD success factors. The journey is enabled by a learning-by-doing approach i.e. Action Learning, which begins with the implementation of a structured NPD process and ends with the implementation of a NPD strategy for sustained success.

3.2.2 Action Research Cycle 2

Application of the Logical Learning Model

The learning from the first cycle of action research was transferred to the planning phase of the second cycle, where the Logical Learning model was implemented within a regional programme in the West Midlands, UK that supports innovation within SMEs. Active involvement in a project with the Manufacturing Advisory Service in the West Midlands, UK (MAS-WM) led to the development of the New Product Development Gateway process (NPD Gateway). NPD Gateway has been developed to support SMEs in commercialising new product ideas and in doing so facilitate learning to support the implementation of NPD success factors. This ensures participant SMEs are better equipped to sustain NPD success. Logical Learning is at the heart of NPD Gateway and has been applied to over 40 SMEs within the West Midlands, UK.

Validation of the Logical Learning Model

A formal evaluation of the Logical Learning Model was conducted using Kirkpatrick's Four-Levels model for learning evaluation (Kirkpatrick 1959; Kirkpatrick 1998). The comprehensive and rigorous summative evaluation model was administered in the form of an online self-completing questionnaire. The evaluation proved the significance of the application of the Logical Learning model within NPD Gateway. The results have generated evidence that links the application of the model to learning within SMEs,

learning to changes in behaviour and NPD practices, and changes in behaviour to organisation results.

Final Reflection of Actions and Outcomes

A final reflection of the actions and outcomes of the research identified the extent to which the objectives of the research were met. Opportunities for the further development of the Logical Learning model were identified and established a greater scope for innovation. Additionally the limitations of the research are recognised.

3.3 Summary of the Research Methodology

The purpose of this research was to consider how existing knowledge of the requirements of successful NPD is translated into practice within SMEs. The research was initiated within a real organisational setting with the intention of contributing to improving their NPD practice. Therefore adopting a constructivist perspective to research an action research approach was implemented. The researcher collaborated with working groups within two SME contexts. The process of action and reflections generated knowledge and insights of the organisational challenges SMEs face in adopting NPD success factors and sustaining success. As a result an innovative model has been developed, namely Logical Learning. The model facilitates organisational learning within SMEs to support the implementation of NPD success factors. The model identifies critical NPD success factors and promotes a 'bottom-up' approach to learning and the implementation of the factors within SMEs, which is enabled by a learning-by-doing approach i.e. Action Learning. Logical Learning was applied to SMEs through its implementation within the NPD Gateway process in the West Midland, UK. A formal evaluation validated the significance of the application of the model. Using a rigorous framework for learning evaluations a significant contribution to practice is demonstrated.

4 Exploratory Study Investigating Organisational Challenges

The first research objective was to investigate the organisational challenges that Small-Medium sized Enterprises (SMEs) face in implementing NPD success factors and sustaining good practice. This was achieved during the first cycle of action research (ARC1) through an exploratory study within an SME context. The exploratory study took place over a two year period (January 2007 – 2009) within Magal Engineering Limited (Magal). The researcher led a collaborative NPD improvement project within Magal that enabled practical insights of NPD practices and challenges within the organisation.

Magal Engineering Limited was a privately owned UK-based group of eight SMEs that specialise in the design and manufacture of components for the global automotive market. Magal were 1st tier suppliers to automotive manufacturers including: Jaguar Landrover, Ford and Lotus. Collectively their product portfolio included: Clutches, Flywheels, Pedal boxes, Handbrakes, Cable systems, Jacks and Tyre Carriers. The organisation was formed in 2003 and had since grown through the acquisition and re-structuring of companies which were either in liquidation or administration. These companies were rapidly turned around into stable and profitable enterprises by focusing on the deployment and adoption of lean manufacturing techniques.

The companies within Magal had been independently recognised for the speed and scale of these changes by the Institute of Mechanical Engineers through the Manufacturing Excellence awards scheme (Mx). Between 2004 and 2006 the companies within Magal had achieved several commendations in Change management and also won categories of Process innovation, Financial Performance and best Small-Medium Sized Enterprise (SME) (http://www.mxawards.org/awards/past-winners). Despite these successes Magal recognised that in order to sustain success and remain competitive they needed to renew their NPD process and implement improvements to their approach to New Product Development (NPD).

The NPD improvement project was predominantly based within Automotive Project Driveline Technologies (APDT), an SME within the Magal group specialising in the design and manufacture of automotive clutches. The project resulted in the development and implementation of the Magal Business Management System (MBMS) at APDT. This system included a new and improved approach to NPD, namely the Product Realisation process, which was the focus of the present research study.

During the NPD improvement project, the researcher took actions to implement NPD success factors within the SME. Various methods and media were used to collect, analyse and disseminate data. Evidence has been gathered, enabling knowledge of the organisational challenges SMEs face in adopting and sustaining good NPD practices.

4.1 The NPD Improvement Project within Magal Engineering Limited

Magal Engineering Limited initiated a NPD improvement project in January 2007 with the aim of developing a best practice NPD process for their group of Small-Medium sized Enterprises. The organisation anticipated that the process should be flexible enough to accommodate a wide variety of customers and products whilst ensuring that any legal requirements and quality expectations were not compromised. Having established the NPD process in theory the improvement project would then seek to deploy the process across the group of Magal companies within the UK. Hence implement a common business-wide approach to NPD.

An action research approach was adopted during the project and facilitated the direct involvement of the researcher as a change agent within Magal, devoted to the study and improvement of the organisation. The initial emphasis of the improvement project was placed on gaining access, developing relationships and the formation of a project team. Brief informal introductions were made to establish the role of the researcher within the organisation. Additionally, the researcher shadowed each department to gain familiarity of the business operations. This allowed for informal discussions with members of the SME and initiated relationships building.

A core project team was formed and included the researcher and senior members of the Magal Group and two core SMEs within the group, Magal Metallifacture and Automotive Product Driveline Technologies (APDT). The team included:

- Jennifer Udeh (the author) – Project Manager, Lead Researcher, Developer of Product Realisation Process
- Peter Lee – Engineering Director for the Magal Group
- Dave Shewan – Quality Director for the Magal Group
- Rob Hawkins – Quality Manager for APDT
- Barry Titcomb – Quality Manager for Metallifacture
- Chris Jones – Project Manager for the Magal Group

With consideration to the 'Stage-Gate Process for Designing and Implementing Stage-Gate (Cooper 2001), the team defined four stages of development that the improvement project would progress through:

- Stage 1: The exploratory study of the current approaches to NPD in order to identify areas of improvements – The researcher conducted a review of documents and semi-structured interviews, which provided an understanding of the strengths and weaknesses of the existing approach to NPD within Magal. Fifteen NPD improvement targets were defined.
- Stage 2: The collaborative development of the new approach – The project team defined the overall structure of the new Magal Business Management System (MBMS). The system included a new Product Realisation process, which the researcher developed. Product Realisation defined a Stage-Gate approach to NPD and incorporated NPD success factors.
- Stage 3: The implementation of the new approach within the business – the Product Realisation process was implemented at APDT through a series of presentations and workshops which were delivered by the researcher. The details of the new approach to NPD and the new strategy for project management were communicated during the workshops.
- Stage 4: The evaluation of the new approach – A Lloyds TS 16969 audit verified the implementation of the MBMS and its compliance to the industry quality

standard. A further internal evaluation was developed by the researcher and administered to personnel within the SME to assess the effectiveness of the design and implementation of the system at APDT.

4.1.1 Existing Approaches to New Product Development within Magal

Knowledge and understanding of current approaches to NPD within Magal were developed initially through a review of the documented business management systems[2] (BMS) within each of the UK-based companies in the group. An overview of the existing structure and content of the BMS of the two core SMEs within Magal are illustrated in Figure 4-1 APDT Business Process Structure and Figure 4-2 Metallifacture Business Process Structure. The figures identify the core processes within each system.

Both systems defined a process for NPD, which was based on the highly acclaimed Stage-Gate structure (Cooper 2001) however the processes differed in content and presentation:

- The APDT process was 'procedure-based', comprising a comprehensive set of works instructions, which consisted of descriptive lists of NPD activities to be undertaken during projects. NPD activities were defined across multiple works instructions. Significant strengths of APDT's documented processes included the definition of project categories, an initial project feasibility review and a cross-functional team approach.

- The Metallifacture process was presented diagrammatically, utilising flow diagrams (Figure 4-3 Metallifacture NPD Flow Diagram) which specified workflow, activities and respective functional responsibilities. Significant strengths of the Metallifacture approach included the definition of mandatory project reviews involving senior management, reference to the review of NPD performance measures at management reviews and reference to a lessons learned database.

[2] This system was also referred to as the Quality Management System (QMS) and was accredited to ISO Standard 14949

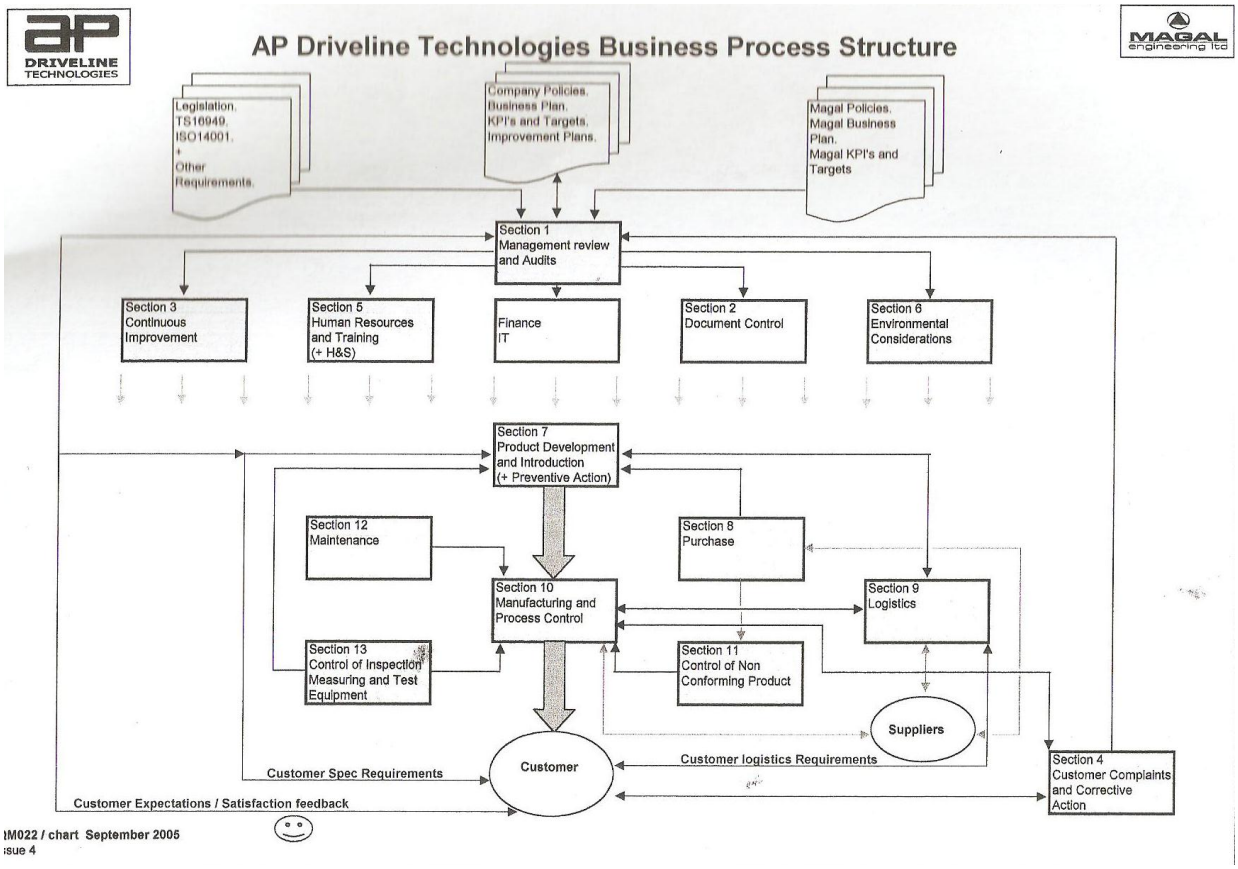


Figure 4-1 APDT Business Process Structure

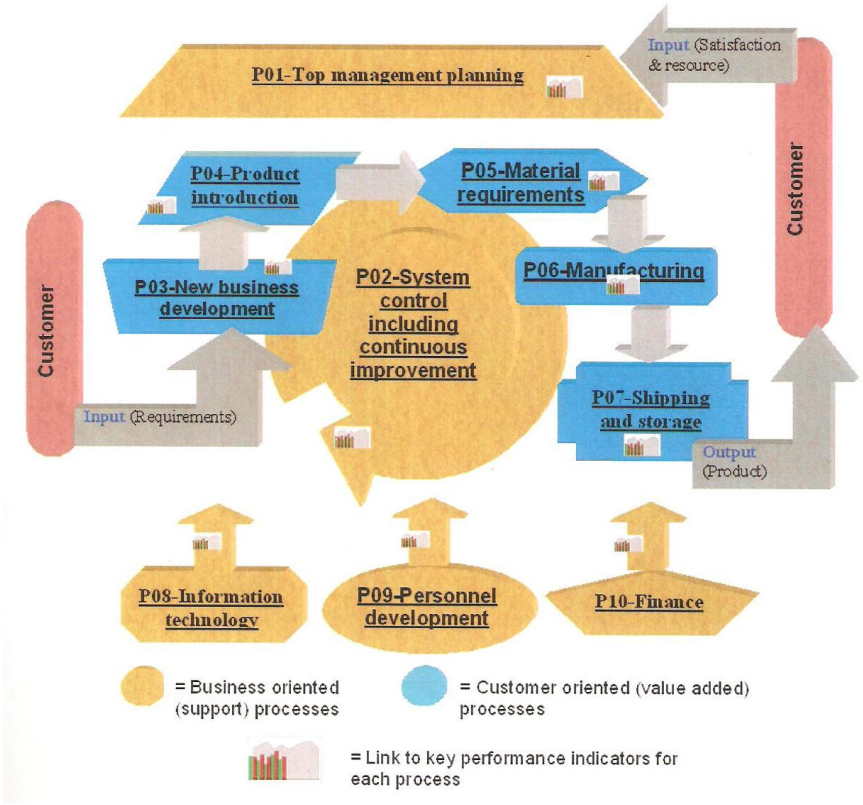


Figure 4-2 Metallifacture Business Process Structure

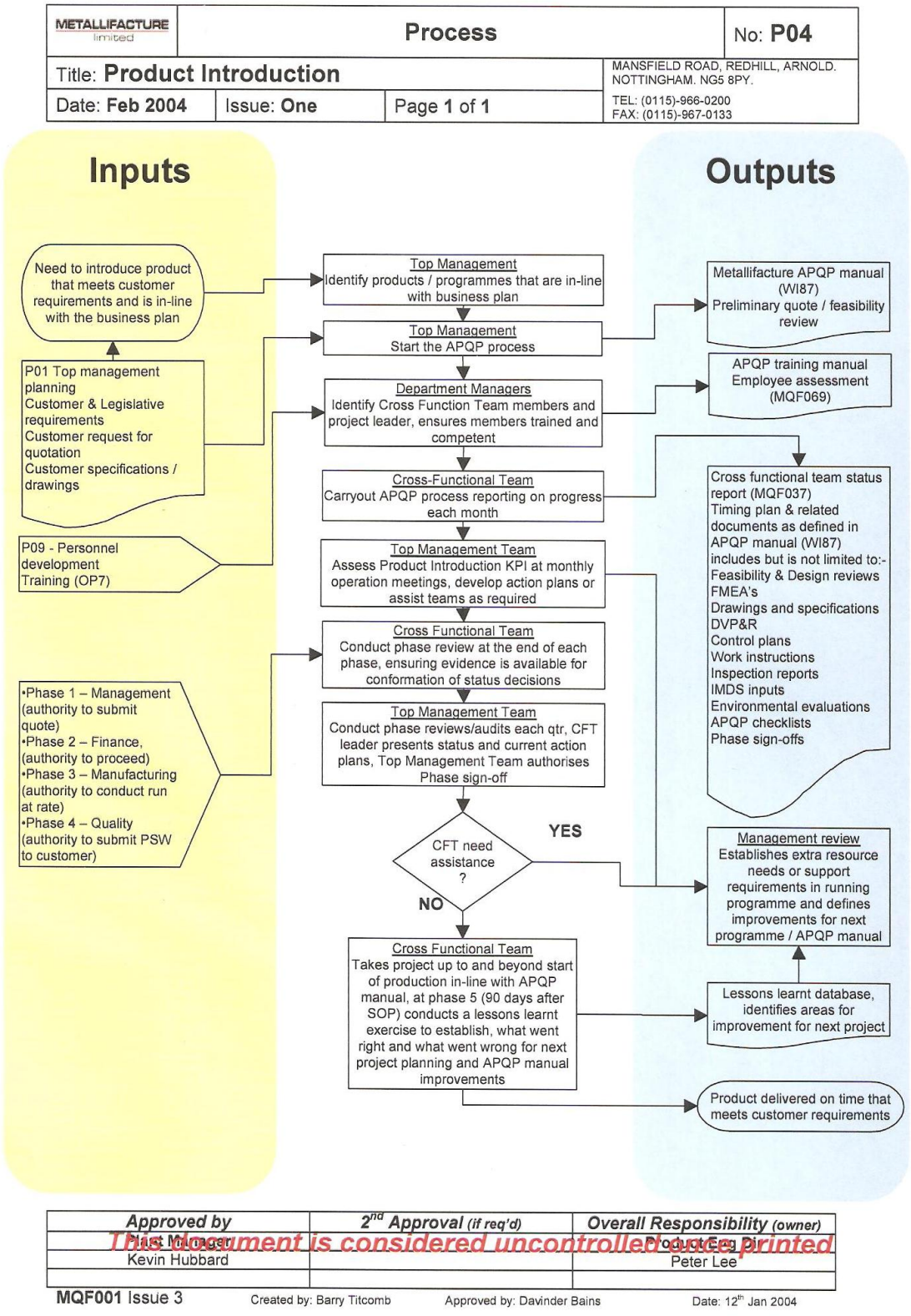


Figure 4-3 Metallifacture NPD Flow Diagram

A review of the detail within the documented NPD processes identified opportunities to improve the definition, implementation and management of NPD within the companies. The detail and presentation of the current NPD processes could be improved to enable greater understanding and guidance as to the activities that were required to be completed during NPD projects. Furthermore, the current processes were viewed as overly complex in terms of structure, which was perceived to be detrimental to the implementation and management of the processes. These areas for improvement were further supported by the findings of semi-structured interviews, which identified existing concerns within the organisation regarding NPD.

The interviews confirmed a limited understanding of the overall BMS within the organisation and consequently a lack of ownership of activities during NPD projects. One respondent commented: *"a lot of people don't understand their responsibilities and consequences"*.

There was a lack of rigour in the implementation of the companies NPD processes. During the interviews the majority of respondents stated that *"no process was being followed"*. Further enquiry identified that Magal's current approaches to NPD were perceived as unstructured and unorganised due to a lack of discipline.

Additionally, factors relating to resource management were the most frequently cited NPD concern within the business. Specifically, respondent's comments included:

- *"We are asked to do too many things, it is difficult to concentrate on the right way to do things"*
- *"As a business we accept everything under the sun with no regard as to whether or not we are capable."*

As a result of the review of current approaches, a mandate for a new *simple and visual* Magal Business Management System (MBMS) was agreed to include the definition of an improved approach to NPD. Targeted improvements were captured in the definition of fifteen NPD improvement statements, which focused on improvements to the structure,

management and understanding of the business's NPD process and individual responsibilities.

4.1.2 The New 'Product Realisation' Process

A new process for NPD was developed and called the 'Product Realisation Process'. This process was recognised as one of four core business process within the new Magal Business Management System (MBMS). Table 4-1 Four core business processes within the MBMS, defines the scope of Product Realisation and the additional three core business process. While the present research defined the scope of all four core processes, the focus was on the detailed development of the Product Realisation process. The development of this process was based on a Stage-Gate approach and targeted improvements to the structure, management and understanding of the NPD process and individual responsibilities.

Table 4-1 Four core business processes within the MBMS

Core Process (CP)	Description
CP1: Business Management & Performance	Defines the process for developing the business plan and managing all aspects of the business including: customer requirements/satisfaction, objectives, continuous improvement and legislative requirements
CP2: Product Realisation	Defines the process for product realisation from customer enquiry through to approved production process
CP3: Supply Chain Management	Defines the process for on-going manufacturing and support activities following production process approval
CP4: New Business Development	Defines the process for the implementation of group strategies and the business plan through to customer enquiry

Figure 4-4 Magal Business Management System Map, provides an overview of the structure and contents of the new MBMS that was developed and highlights the Product Realisation process, which was the focus of this research. A three tier structure was defined to enable an improved understanding of business approaches and practices. Level 1 provided a one-page overview of each core process. Level 2 consisted of the Activity Charts that detailed the sub-processes and activities involved, and Level 3 consisted of the supporting forms for each core process.

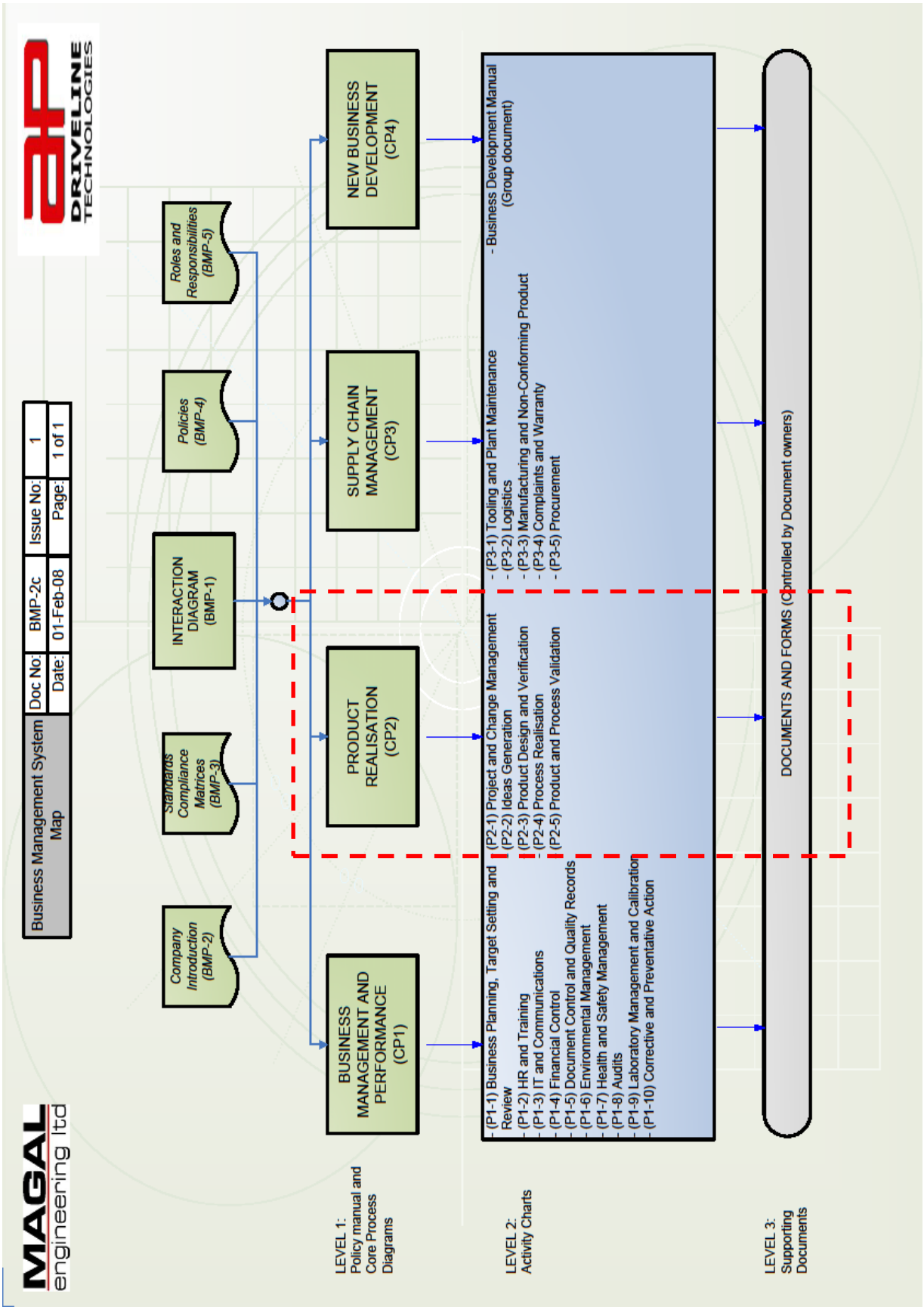


Figure 4-4 Magal Business Management System Map

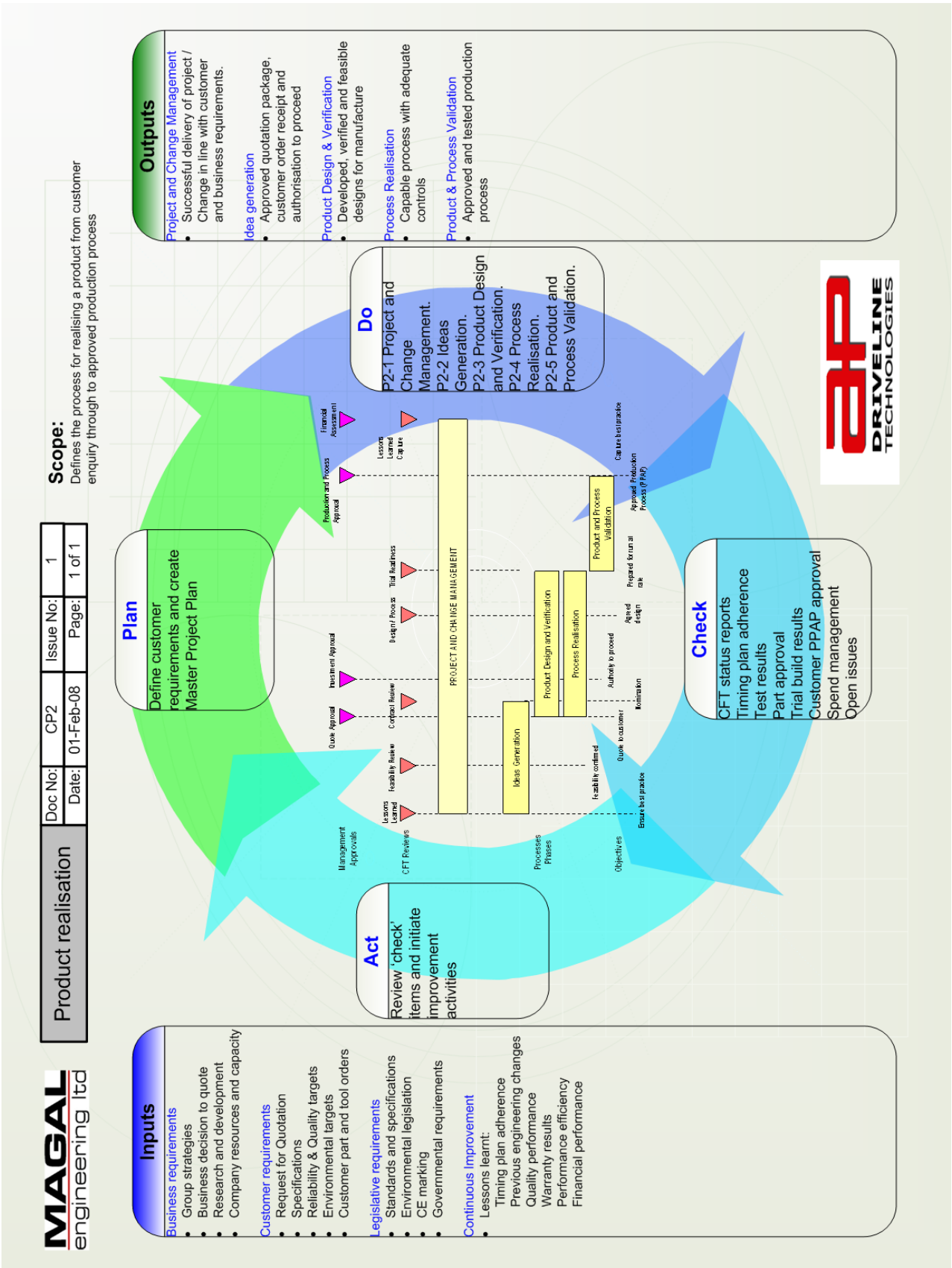


Figure 4-5 Product Realisation Core Process Diagram

An overview of the Product Realisation process is provided in Figure 4-5 Product Realisation Core Process Diagram.

Overall, the process consisted of the following elements:

- Structure Stage-Gate process approach
- Activity charts for each stage of the process
- Master Project Plan and other supporting forms

Based on a Stage-Gate structure (Cooper 2001) and with consideration to 'best practice' literature and the ISO/TS 16949 quality standard, four stages of the Product realisation were defined and outlined in scope (Table 4-2 Stages within the product realisation process).

Table 4-2 Stages within the product realisation process

Stage	Description (output)
Ideas Generation	Approved quotation package, customer order receipt and authorization to proceed
Product Design and Verification	Developed, verified and feasible designs for manufacture
Process Realisation	Capable process with adequate controls
Product and Process Validation	Approved and tested production process.

Decision gates were defined within the Product Realisation process, where project progress is assessed. These gates were designed to enable senior management to assess project progress and enable the effective management of risk during NPD (Cooper and Kleinschmidt 2007). The gates were also designed encouraged discipline during NPD. Two types of decision gates were established to ensure an effective and efficient process:

1. Management approvals - which identified senior management decisions/involvement
2. Cross-functional team reviews – which defines reviews and decision points the team would be responsible for conducted

As an additional control during the process, senior management held formal quarterly reviews of all NPD projects to review project team decisions and project progress. These quarterly management reviews were defined within Core Process 1 (CP1).

Figure 4-6 Product Realisation flow diagram provides an overview of the stages and gates within the process.

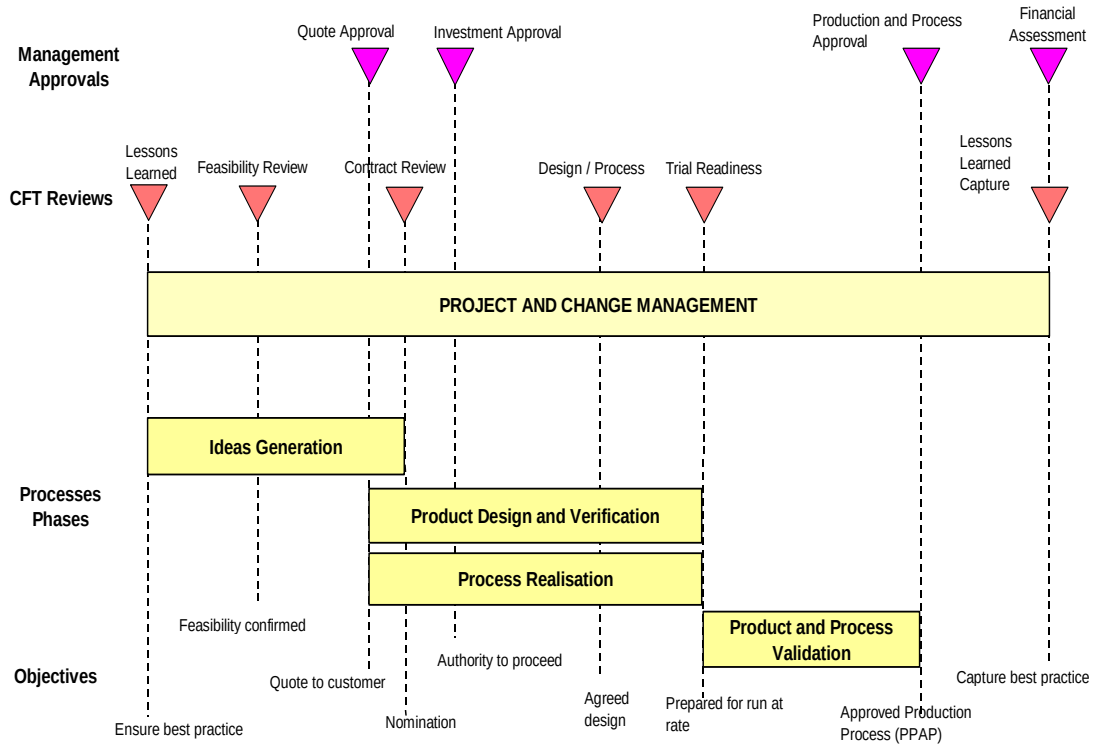


Figure 4-6 Product Realisation flow diagram

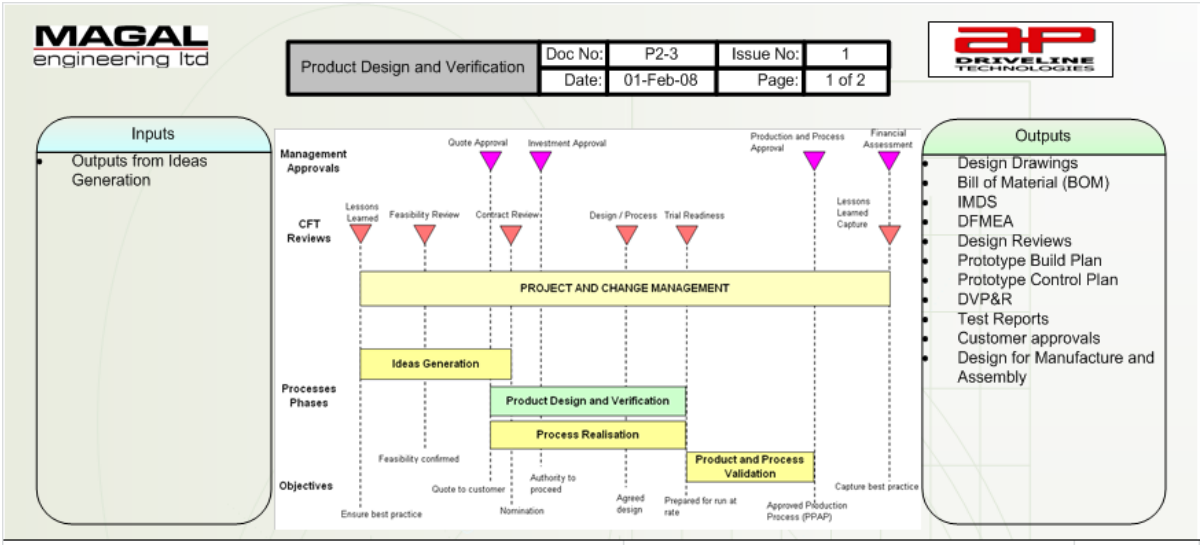
With consideration to the structure and presentation of the Metallifacture and APDT process, activity charts were developed, which provided a template on which the sub-processes and activities within each core business process were defined. To further

improve understanding of the NPD process and individual responsibilities, each stage of the product realisation process was defined on a separate activity chart, which included the identification of the process owners, activities within the process, responsibilities and supporting forms (output). To encourage ownership of the Product Realisation process within the business, at this stage of development sub-process owners were nominated to facilitate the definition of the activities, deliverables and responsibilities. The process owners supported collaborations with the necessary business areas to identify and agree the details of the process and ensure accountability and commitment. An extract of the product design and verification activity chart is provided in Figure 4-7 Extract from Product Design and Verification Activity Chart.

Finally, improvements to the management and organisation of NPD within the SME were targeted and considered: project planning, project leadership, NPD performance measurements and portfolio management. Although the organisation recognised the importance improvements to all these areas, they were not receptive to major successful changes to portfolio management and NPD measures. The result was the development of a new procedure of Project Management (activity chart) and the Master Project Plan (supporting form).

The Master Project Plan (MPP) was developed to support the planning, monitoring and control of NPD projects. Together with the project management procedure this established a new strategy for project management within the SME. The MPP provided a comprehensive one-page report which provided greater visibility of project status. The Plan inherently provided an indication of resource capabilities during projects through a measure of departmental statuses. This was achieved by including a red, yellow, green (RYG) status for departments which related to the completion of the activities defined. This measure was used to provide visibility of resource constraints in order to encourage portfolio management.

Figure 4-8 Key Elements of the Product Realisation Process illustrates the relationship between the key elements of the Product Realisation Process.



Process Owner: Peter Lee

Activity / What	Req'd		Who		When	HOW	Output
	M/O	A	Owner	Contributes			
Note! Throughout this procedure appropriate reference should be made to both the AIAG APQP manual and the customer specific requirements, Due consideration to Customer information security, Statutory requirements and Regulatory requirements associated with the product should be given throughout this procedure.							
1. Planning & Management							
1.1. Update Master Project Plan	Y	O	CFT Leader	CFT	Throughout	**See Project and change management procedure**	
1.2. Review Feasibility	Y	Y	CFT Leader	CFT	Ideas generation & throughout project as required	**See Project and change management procedure**	
1.3. Technical Service Request (TSR)	Y	Y	Sales (for aftermarket) / All Function		As required	Issue to CFT for any activity including tool go (investment approval) and drawing modifications	TSR
1.4. Formal drawing release	Y	Y	Product Engineering		As required	**See Document Control procedure** for Drawing release process	
1.5. Benchmarking and New technology identification	Y	O	Product Engineering		As required	Conduct competitive study including research into new processes and material	
1.6. Design reviews	Y	Y	Product Engineering	CFT	As required	Conduct formal review with standard agenda / check list	Design review document
1.7. Environmental Compliance	Y	Y	Product Engineering	Purchase	Throughout	Work to Black / Grey lists and process guidelines	Environmental Compliance guidelines
1.8. Customer sign-off	Y	O	Product Engineering	CFT	As defined by customer	Ensure sign-off is received for required documents. May include: FMEA, DVP & Drawing.	Sign offs as required
2. Product Development							
2.1. 2D Drawings	Y	Y	Product Engineering		Prototype release Production Release	Generate drawing with aid of Design Guidelines which include guidelines for Part No. establishment and Calculations. **See Document Control procedure.**	Drawings
2.2. Design Analysis	Y	Y	Product Engineering		As required	To include: Calculations; Tolerance analysis; FEA; Material selections; DFM; Part Pedigree;	Reports
2.3. 3D Data	Y	Y	Product Engineering		As required	Generate with aid of Design Guidelines	Models
2.4. DFMEA	Y	O	Product Engineering	CFT	Throughout	Refer to AIAG guidelines (tools incl. Fault tree and boundary diagrams)	FMEA
2.5. Engineering BOM	Y	Y	Product Engineering		Drawing release	Use customer standard part no. convention **See document control procedure**	BOM
3. Prototypes							
3.1. Manufacture Prototypes	Y	O	Product Engineering	Purchase / Process	As required / as defined by customer	Develop drawings, procure prototypes components and material. Develop Control Plan, BOM and Build Plan. Define	Prototype build Control plan

Figure 4-7 Extract from Product Design and Verification Activity Chart

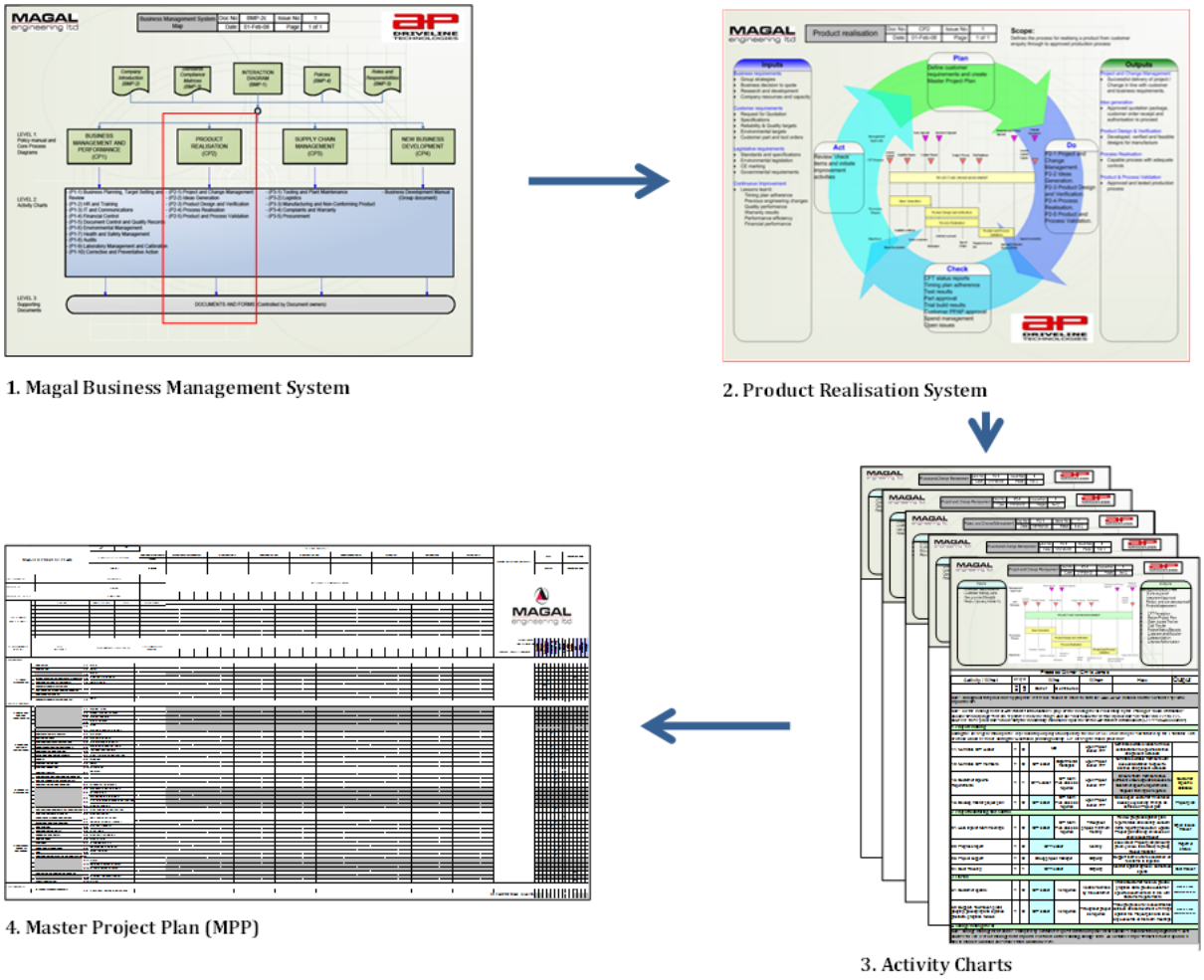


Figure 4-8 Key Elements of the Product Realisation Process

Further details of the development of the Magal Business Management System (MBMS) are provided within the research portfolio in Submission 2 – The Development of a NPD Process within an SME.

The Product Realisation process was launched on 1st July 2008 and initially implemented at Automotive Product Driveline Technologies (APDT) through a series of workshops which were designed and developed by the researcher. These workshops were designed to ensure commitment and buy-in and communicate the structure and details of the process. Instructions on how to use key supporting documents including the master project plan (MPP) were also provided and a user-guide to the product realisation process was developed and distributed to personnel within the organisation.

Additionally utilising existing MS Office capabilities a new electronic document filing structure was developed to support the process and effectively organise and manage project data.

The MBMS was required to achieve TS 16949 accreditation and an interim external audit conducted on 15th July 2008 verified the conformance of the system to the quality standard. Regarding the Product Realisation process the report stated:

"The process appears well-structured and straightforward, with features including a clear definition of core processes and inputs/outputs"

"[A] comprehensive Master Project Plan is in place, which provides details of factors including the stage-by-stage status of the design and associated key activities, documentation checklist, responsibilities by department and those of individual personnel".

The audit validated the appropriate quality of the entire system in terms of the TS standards. To establish the internal value of the MBMS and Product Realisation process at Automotive Product Driveline Technologies (APDT), an internal evaluation of the design and implementation system was conducted in October 2008 (3 months after the launch of the new MBMS). The results of the evaluation demonstrated that the improvement project had had a positive impact on the SME and their way of working:

- 84% of respondents confirmed improvements to the clarity and understanding of business approaches and practices
- 60% of respondents confirmed increased visibility of project status
- 60% of respondents confirmed more discipline culture
- 70% of respondents confirmed a more organised approach to NPD.

However, the achievements were limited in that the research was yet to influence the business's overall NPD Strategy. This was attributed to existing organisational challenges that are discussed below.

4.2 Organisational Challenges

The development and implementation of Product Realisation at Magal Engineering Limited (Magal) provided practical insights into the implementation of NPD success factors within an SME. A reflection of the actions and outcomes considered data gathered from various sources including: semi-structured interviews, observations and an internal evaluation within Magal. Knowledge of the organisational challenges faced during the NPD improvement project was generated. As a result, the research question was refined to a focus on learning as an appropriate mechanism to support the implementation of existing knowledge of the requirements of successful NPD within SMEs and to renew good practices.

A detailed account of the actions reflected upon in this section, is provided in the research portfolio in Submission 2 – The Development of a NPD Process within an SME.

4.2.1 The People, Process, Political and Technology Challenge

A number of organisational challenges were observed and experienced first-hand during the NPD improvement project. These challenges influenced the development and implementation of appropriate NPD practices within the SME and were considered to have influenced the SMEs ability to sustain prior implementation efforts. These challenges were categorised into four areas as illustrated in Figure 4-9 Organisational challenges within SMEs:

- The people challenge referred to the collective challenge of developing knowledge and capabilities. This included ensuring the knowledge of both the requirements of NPD success and once improvements were implemented, ensuring an understanding of the changes introduced. Furthermore, the 'people challenge' included the challenge in developing capabilities within the SMEs to implement NPD success factors.
- The process challenge referred to the challenge of developing appropriate approaches by tailoring 'best practice' to suit the organisational context i.e. an SME.

- The political challenge referred to the challenge of ensuring power and influence in order to facilitate improvements and change. This included achieving commitment and ownership of new NPD practices and ensuring NPD process governance.
- The technology challenge referred to the challenge of justifying and achieving investment in appropriate technology that would not only support the management of NPD but also potentially improve the nature of the product offering.

It was determined that these challenges were inter-dependent and interacted to influence the adoption of NPD success factors within the SME.

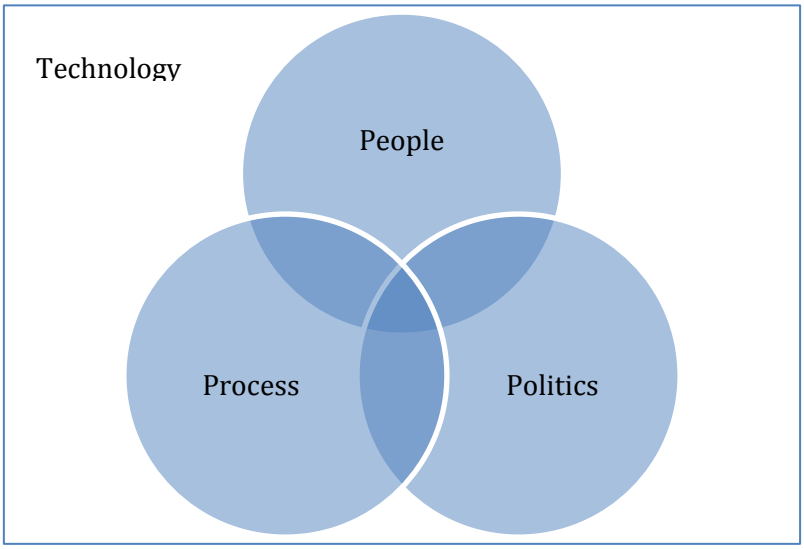


Figure 4-9 Organisational challenges within SMEs

Limited knowledge and capabilities were established during the initial review of current approaches. Semi-structured interviews identified pockets of awareness of the requirements of NPD success. When asked to comment on potential improvements to the SMEs approaches, some respondents demonstrated knowledge of the critical NPD success factors. These included: the effective management and organisation of projects, resource management, a NPD strategy and proactive organisational culture. However, the review found that these factors were not being adopted, which suggested among other things limited existing capabilities to implement organisational knowledge. This capability was in part developed as evidenced in the implementation of the new Product

Realisation process that included a structured process approach and project management strategy. However, the evaluation of the MBMS identified a further challenge of ensuring understanding of the new business process itself. In the evaluation of the improvement project the majority of respondents (51%) indicated that only a "basic" understanding of the process had been achieved so far.

Limited capabilities to implement improvements were also related to the 'process challenge' of tailoring the requirements of successful NPD to appropriate practices that suit the SME. There is no one-size-fits-all approach to NPD and the design of the business process was dependant on the structure, resources and culture of the organisation. During the development of the new Product Realisation process, the SME's strategy for project management i.e. the project management procedure and master project plan (MPP) had to be tailored to suit the existing management structure and technology capabilities. The development of an appropriate approach required not only an understanding of the principles of 'best practice' for the organisation and management of NPD projects. It also required the capability to translate the principles into approaches that would work within the SME context in which they were being introduced to.

Additionally, political activities surrounded the NPD improvement project. Markham and Holahan (2005) attribute this to the nature of product development, which involves the allocation of resources, control and issues of strategic direction. Politics influences the ability to facilitate planned changes within organisations and concerns issues of power and influence (Kumar and Thibodeaux 1990). During the NPD improvement project this challenge referred to the ability to influence change in all areas and at all levels of the SME. While the improvement project engaged with all areas and levels, the evaluation indicated that: ownership, adherence and awareness of the business process within the SME still required further improvement. During the improvement project power and influence were required to encourage empowerment, commitment and participation in the development and implementation of the planned changes.

Humphreys, McAdam et al. (2005) establish that an innovative culture and leadership is important in innovation implementation. The organisation's culture must encourage

empowerment and participation. Moreover, leadership is necessary to overcome any resistance to change.

Change is inherent in the nature of innovation and essential for establishing and maintaining a competitive advantage. Businesses are increasing having to develop the capability to continually adapt their approaches. Therefore, overcoming the 'political challenge', that is ensuring the power and influence required to facilitate change is essential for sustained NPD success.

On reflection of the NPD improvement project, it was identified that the implementation of the more 'strategic' success factors of NPD within the SME were dependent on overcoming the political challenge. This included influencing changes to NPD performance measurement, portfolio management, and the development of NPD strategy. It was experienced during the project that the consideration of these areas required a commitment and participation at the board level of the SME and was not achieved. Adequate changes to these areas were not achieved during the project.

Furthermore, a commitment and investment in technology is essential for sustained NPD success (Garside 1998; Trott 2008). A diverse and changing technological knowledge-base is increasing the variety of new product offerings and the speed in which these offering are introduced into the market (Clark and Wheelwright 1993). More organisations are recognising technology as a key element of their NPD process and are integrating their technology management process within their NPD process i.e. by way of technology routes maps. During the NPD improvement project technology solutions were considered to support the execution and management of the Product Realisation process. However, the justifications of investment in such solutions were not accepted. This was attributed to limited financial resources, which has been identified as a common problem for SMEs who not only lack capital expenditure on technology but also typically have insufficient expertise to use technology to its maximum effectiveness (Humphreys, McAdam et al. 2005; Storey and Greene 2010).

The technology challenge involved ensuring an understanding, capability and commitment to new technology. Technology is required to be tailored for suitable

application within the SME. Furthermore a degree of influence is necessary to justify investment in its implementation. Therefore it was determined that this challenge encompassed all other challenges identified as illustrated in Figure 4-9 Organisational challenges within SMEs.

4.3 Re-framing the Research Question

Despite the substantial body of knowledge regarding NPD success factors, in practice implementation challenges are common when introducing a new approach (Cooper 2001). The NPD improvement project had identified organisational challenges relating to: people, process, politics and technology that had influenced the adoption of NPD success factors within an SME. However, despite these challenges an internal evaluation had demonstrated that the actions taken during the project has begun to overcome these challenges and had had a positive impact on the organisation and their way of working. The action research approach had enabled learning and the practical implementation of NPD success factors, such that a structured process approach and new approach to project management had been implemented within the SME. This has been achieved through the development and implementation of the Product Realisation process. These achievements were limited to the implementation of success factors relating to the structure and activities defined within of a company's NPD process and the way projects are organised. The research was yet to influence the more strategic areas of NPD, such as portfolio management and the business's NPD strategy, which are essential for sustained NPD success.

On reflection it became apparent that it would be continuous learning that would enable the SME to develop further capabilities that would take them further on their journey towards implementing NPD improvements. The research focus was refined to consider 'organisational learning' within SMEs, where learning was defined as *"the human process by which skills, knowledge, habit and attitudes are acquired and altered in such a way that behaviour is modified*" (Beach 1980, as cited by Robert 2000). Organisational learning was considered an appropriate mechanism to translate existing knowledge of the requirements of NPD success into appropriate practice within SMEs, by ensuring the development of the knowledge, capabilities and commitment necessary to overcome

organisational challenges and influence organisational practice. The validity of this hypothesis was support by Chaston Badger et al. (1999), who had established a relationship between organisational learning, organisational capabilities and organisational performance.

Consequently, the second research objective was refined to consider mechanisms that effectively facilitated learning within SMEs to support NPD. Therefore the original research question was re-framed as follows:

How is organisation learning (i.e. the development of knowledge, skills and attitudes) facilitated within SMEs, to support the implementation of NPD success factors and sustained success?

4.4 Summary of Exploratory Study

An exploratory study was conducted with the objective of investigating the organisational challenges an SME faced in implementing NPD success factors. The study took place within Magal Engineering limited over a two year period from January 2007 through to January 2009. The researcher led an NPD improvement project within the SME that sought to implement NPD success factors. The project resulted in the development of the Magal Business Management System (MBMS). The MBMS included a new structured approach to NPD and project management strategy, which implemented improvements to existing approaches to NPD. These components were collectively defined as the Product Realisation Process.

Initially a review of currently approaches to NPD within the SMEs established limited understanding and ownership of the organisations approach to NPD such that “no process was being followed”. The management of resources and strategy for project selection were also identified as opportunities for improvements. Therefore with consideration to NPD success factors, research efforts sought to develop a NPD process which implemented improvements to the structure and management of NPD within the SME and understanding of the business’s process and individual responsibilities.

The MBMS including the Product Realisation was launched on July 1st 2008 and an internal evaluation demonstrated that improvements had been made to the businesses approach to NPD. However, the achievements were limited in that the research was yet to influence the business's overall NPD Strategy including areas such as portfolio management.

A reflection of the action and outcomes of the NPD improvement project generated knowledge of organisational challenges that influenced the development and implementation of appropriate NPD practices during the NPD improvement project. These challenges were categorised into four areas:

1. The people challenges of developing knowledge of good practice NPD and the capability to implement this knowledge with the SME.
2. The process challenge of developing appropriate approaches by tailoring 'best practice' knowledge to suit the organisational context.
3. The political challenge of ensuring power and influence at all levels within the SME in order to facilitate improvements and change.
4. The technology challenge of justifying and achieving investment in appropriate technology to support NPD efforts.

It was established that despite these challenges the actions taken during the project had ensured organisational learning, which had begun to influence organisational capabilities and practices. It would be this continuous learning that would continue to develop the knowledge, capabilities and commitment necessary to facilitate further improvements.

5 Development of the Logical Learning Model

The second research objective was to develop a mechanism that overcame organisational challenges and facilitated the implementation of NPD success factors within an SME. The exploratory study had established that this mechanism would facilitate organisational learning in order to develop organisational knowledge, capabilities and commitment, which would improve NPD practice. Over a one year period beginning in January 2009 a conceptual model, namely Logical Learning was conceived and developed. This was achieved with consideration to a review of literature on existing learning models, the actions and outcomes of the previous exploratory study at Magal Engineering Limited and discussions with research participants.

5.1 Review of Existing Approaches to Organisational Learning

Existing approaches to organisational learning were identified within the literature and considered for their application to support the implementation of NPD success factors within SMEs and sustained success. Four approaches were selected as they provided appropriate and different perspectives of the facilitation organisational learning:

1. The Three Learning Modes
2. Action Research and Action Learning
3. Focus, Will, Capability Performance System
4. Audit Tools

5.1.1 The Three Learning Modes

The three modes of learning provide insights into how learning can 'mature' in organisations. It describes a three staged model of development, where subsequent stages or modes are additive and incorporate the previous stages as illustrated in Figure 5-1 the three learning modes. The modes describe how organisations learn to implement, improve and integrate (Pedler, Burgoyne et al. 1997):

1. *Implement* - the organisation does things well. Characterised by constant reliability but limited by lacking responsiveness to changes in the environment. Standards fall due to lack of systematic improvement procedures.
2. *Improve* - the organisation does things better. Characterised by initiative-taking and continuous improvement through systematic feedback and reflection. But constrained to improvements within existing boundaries.
3. *Integrate* – the organisation does better things. Characterised by creativity through holistic, systematic problem solving and dialogue. This type of learning creates new possibilities and contributes to sustaining the wider world of which organisations are part of.

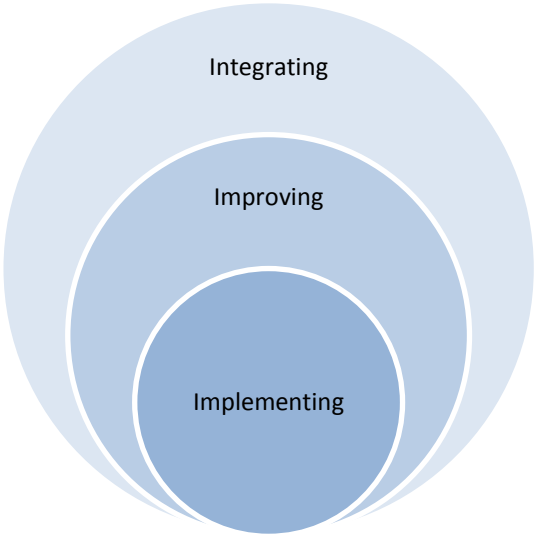


Figure 5-1 the three learning modes
Source: reproduced from (Chaston, Badger et al. 1999)

This model effectively identifies three stages of an organisation's learning journey towards not only adapting to their environments to sustained success (i.e. improving) but also developing new environments which contribute to the development of the organisation's wider context. It identifies that the present research focus on learning to support the implementation of NPD success factors within SMEs and sustained success concerns two of three types of learning i.e. "doing things well" and "doing things better".

There is a potential for the research to extend to learning that impacts the wider context of NPD, which is external to SMEs.

5.1.2 Action Learning and Action Research

Zuber-Skerritt and Perry (2002) distinguish between two terms: action learning and action research. They argue that action learning is inherent in action research and not vice versa. However the two terms overlap (Coghlan and Pedler 2006) and share core values including, "practical action" and "collaboration" to support the development of people and/or organisation. The term action learning can be used to describe the learning facilitated by the action research process. Like action research, it involves working in collaboration within an organisational context through phases of action and reflection (Ravans 1982). Furthermore, both terms involve learning in action i.e. 'learning-by-doing'. Hence within the present research Action Learning and Action Research are referred to collectively as 'Learning-by-Doing'.

Action research defined the methodology adopted during the present research study, as described in Chapter 4- Research Methodology. The achievements of the application of action research to the development of the Magal Business Management System (MBMS) demonstrated that 'learning-by-doing' can support the implementation of NPD success factors within an SME. However, the achievements had so far been limited and had not influenced all areas of NPD i.e. NPD strategy. Therefore, further consideration of the literature was required to establish the appropriateness of the methodology for the purpose of this research. That is, to facilitate organisational learning to support the adoption of good NPD practice within SMEs and the sustained NPD success.

Action learning and action research are relevant for organisational, professional and personal development, and have become popular in development programmes (Howell 1994). That is because they are: work- related, results-based, group-focused and appropriate to the preferred learning styles in organisational fields. These factors have been established as appropriate for facilitating learning within SMEs as SMEs are most influenced by learning from experience and activity based development within an organisational context (Choueke and Armstrong 1992; Choueke and Armstrong 1998).

However, recent literature also identifies the importance of a coach or facilitator to ensure organisational learning by way of action learning. The action learning coach is required to identify learning opportunities and enable the reflection necessary to improve practice (Freedman 2010). This is comparable to the role of a mentor when facilitating learning within SMEs, as established by Sullivan (2000). Sullivan (2000) argues that effective learning within SMEs is better ensured by a mentor whose role it is to enable reflection on actions and facilitate learning from "critical incidents".

Therefore, it was identified that 'learning-by-doing' was an appropriate approach for facilitating learning within an SME. Additionally, the achievements of this approach were also dependent on the ability of the action learning coach/mentor to facilitate action and reflection. Furthermore, the achievements also depended on the existence of "critical incidents", which provide appropriate the opportunity to learning.

5.1.3 Focus, Will, Capability Performance System

The focus, will capability performance system (F/W/C-P System) is founded on a perspective of learning as a guiding principle as oppose to a process. It is a "dynamic" model that facilitates learning by identifying concepts or "fields of meaning", which individuals and organisations use to attain a desired performance (Smith and Tosey 1999). The F/W/C-P System describes three "fields" or elements: focus, will and capability, which form a dynamic system that influences performance (Figure 5-2 The performance system):

1. Focus represents a clear definition and understanding of the performance proposed e.g. the identification and understanding of NPD success factors that SMEs intends to implement.
2. Will represents the strength of the intent to action the performance defined in Focus and is associated with attitudes, emotions, beliefs and mind-sets e.g. the strength of the commitment/intention to implement NPD success factors
3. Capability represents the ability to transform into reality the performance defined in Focus e.g. the capability to implement NPD success factors. Capability

is associated with such diverse areas as skills, infrastructure, budgets, tools, physical assets etc.

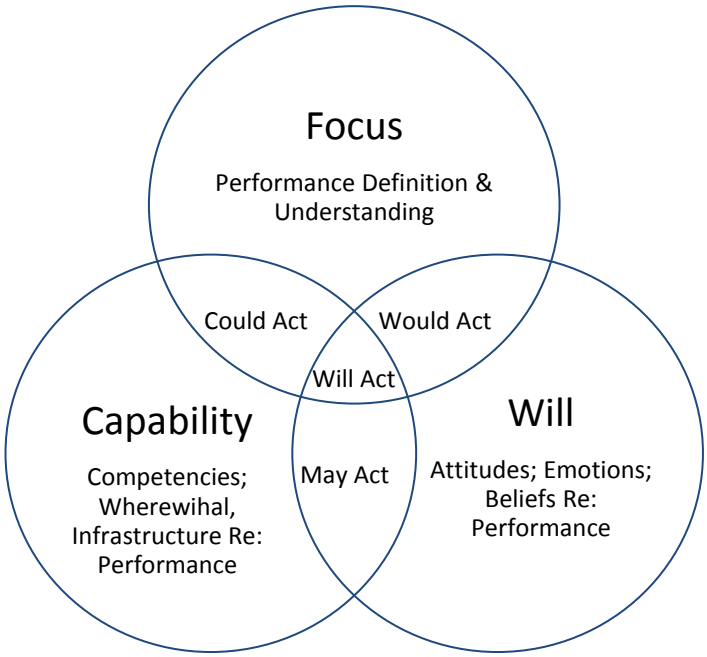


Figure 5-2 The performance system
Source: adapted by the author from (Tosey and Smith 1999)

Ideal performance (i.e. focus, will and capability) is the desired behaviours (or practices) defined by the organisation and current performance depends on the interactions and interdependencies of the three components. As illustrated in Figure 5-2 The performance system, the most favourable set of conditions for optimal performance is when focus, will and capability are in balance.

The F/W/C-P System facilitates organisational learning by providing a "visionary core" that can be used to guide improvement plans. Tosey and Smith (1999) associate the three "fields" to "levers" that can be set in principle to position learning goals. These levers can then be monitored and measured via instruments such as questionnaires.

The strength of this model is in the identification of the relationship between three components (fields) that influence organisational performance and practice. The

measurement element is also useful in operationalising this model. Furthermore, as the model allows the organisation to prescribe their desired performance, it provides a flexible guide which can apply to the facilitation of various learning goals including the adoption of successful NPD practices.

However, for its application to the present research the performance achieved would be dependent on the desired goals set by the organisation, therefore further guidance may be required to ensure effective performance goals are set with consideration to 'best practice' NPD.

5.1.4 Audit Tools

Audit tools facilitate learning by using measurement as a basis for establishing current status and guiding improvements. However, as reported in Moultrie, Clarkson et al. (2007) *"Auditing goes beyond measuring: it builds on this to identify gaps between current and desired performance, and provides information that can be used in developing action plans to improve performance."* (Chiesa, Coughlan et al., 1996)

There are various approaches to measurement which can be implemented within audit tools. The F/W/C-P System provides one approach to measurement that considers three components (i.e. fields). Additionally, Table 5-1 Approaches to auditing processes, illustrates alternative methods ranging from simple binary 'yes-no' assessments to more comprehensive maturity-based assessments.

Moultrie, Clarkson et al. (2007) establish: at one extreme, Scale 1 – binary yes/no scale - while relatively simple, provides limited information about what constitutes good practice and is highly subjective. Scale 3 – modified likert-style scale – provides greater insights into the potential extremes of performance, however provides limited information on intervening points or how an organisation might migrate to the higher levels. Maturity-based assessments, i.e. Scale 4 – maturity scale with multiple anchor phrases, and Scale 5 – maturity grid with extended descriptions – provide intermediary descriptions that can provide comprehensive insights into good practice and how organisations might progress between each level.

Table 5-1 Approaches to auditing processes

Scale 1: Binary Yes/No Scale

Do you involve your customers and users in NPD?

Yes No

Scale 2: Likert-Type Scale

We always involve our customers and users.

1	2	3	4	5	6	7
Strongly Disagree		Disagree		Agree		Strongly Agree

Scale 3: Modified Likert-Type Scale

How do you involve your customers and users?

1	2	3	4	5	6	7
Users Rarely involved						Relevant stakeholders involved throughout

Scale 4: Maturity Scale with Multiple Anchor Phrases

Ongoing User Involvement

Level 1	Level 2	Level 3	Level 4
Users Rarely Involved	Users Sometime Involved at the start	Users Involved at start and end	Relevant Stakeholders Involved Throughout

Scale 5: Maturity Grid with Extended Descriptions

Ongoing User Involvement

Level 1 Users Rarely Involved	Level 2 Users Sometime Involved at the start	Level 3 Users Involved at start and end	Level 4 Relevant Stakeholders Involved Throughout
• Users rarely involved at all • The only contact with users is through the sales force	• Users occasionally asked for early input • Some feedback may be sought after product launch • A marketing task-results not widely disseminated	• Users are always involved early-typically during product definition • A marketing activity, but responses are collated and fed back to the core team	• Users involved throughout, including idea generation, concept selection, and evaluation of prototypes • Internal and external stakeholder involvement

Source: adapted by the author from (Moultrie, Clarkson et al. 2007)

It was identified that the ability of maturity-based tools to provide both insights into best practice and the process (levels) to achieving best practice was an advancement of the three approaches to organisational learning considered so far. It effectively combined a model to guide improvements and a mechanism to facilitate learning. For this reason, maturity-based audits tools were considered further.

Maturity-based audit tools have become a popular way of capturing good practice knowledge in a form that supports improvement initiatives (Moultrie, Clarkson et al. 2007). The concept of process capability maturity has stemmed from quality management principles and established the extent to which a specific process was explicitly defined, implemented and made effective through continuous improvement (Paulk, Curtis et al. 1993). This concept had been used to develop tools that enabled organisations to assess their process capabilities and guide improvements based on descriptions of incremental stages or levels of development.

The most widely recognised approach to maturity-based tools are Capability Maturity Models (CMM). Originally developed by the Software Engineering Institute (SEI), CMMs describe evolutionary improvement paths from an ad hoc, immature process to a disciplined, mature process with improved quality and effectiveness (CMMI 2010). The "maturity levels" defined within the model enable organisations to prioritise improvements. Furthermore, at each level of the model, process assessment are combined with capability evaluations to provide guidance on the control and improvement of software design and enable the selection of improvement strategies based on current performance (CMMI 2010).

Based on the SEIs framework, comprehensive CMMs have been developed and applied to various aspects of innovation and NPD e.g. (Ibbs 2000; Lockamy III and McCormack 2004; Kerzner 2005; Bititci 2008). Further examples can also be found in Moultrie, Clarkson et al. (2007). However, due to the time and resources required to administer the models, they are considered to provide a comprehensive and rigorous solutions at the expense of accessibility (Sheard 1997). This is particular true for their application within SMEs who are typically constrained by time and resources for improvement

initiatives. Therefore it was determined that SMEs required a less resource intensive solutions to those that had already been defined.

However, the concept of capability maturity promoted by the existing models was considered applicable to NPD. Furthermore, the ability of the model to prioritise improvements based on recognition of levels of capability was considered useful for supporting the implementation of NPD success factors within SMEs. This was due to a resource constraint that has been identified as a typical characteristic of this type of business. Similarly to The Three Modes of Learning (Pedler, Burgoyne et al. 1997), capability maturity levels identified an organisation's learning journey. Moreover, they achieved this in a way that captured knowledge of best practice to further facilitate learning.

5.2 The Requirements for a New Learning Model

The review of existing approaches to organisational learning contributed to understanding and provided insights into the requirements of an approach to support the implementation of NPD success factors within SMEs and sustained success.

Table 5-2 Four existing approaches to learning provides a summary of the advantages and disadvantages of the four existing approaches to organisation learning that were considered.

Table 5-2 Four existing approaches to learning

Existing Learning Models	Advantages	Limitations
The three learning Modes	Provides insights of how learning can develop in organisations: • Implementing • Improving • Integrating	No mechanism to support practical implementation within SMEs Requires a mechanism to relate to 'best practice' NPD
Focus, Will, Capability Performance System	Identifies how three components of learning interact and influence performance.	Operation of model presumes knowledge of 'best practice' NPD

Action Learning (inherent in Action Research)	Relevant for organisational development Appropriate and preferred learning style for SMEs	Dependent on a coach/mentor and the existence of "critical incidences" that provide appropriate opportunities to learn
Maturity-based audit tools	Combine descriptive knowledge of 'best practice' with the definition of incremental development stages that prioritise improvements	Typically very resource-intensive and inaccessible to SMEs Existing models do not capture knowledge of all areas of NPD

Source: The Author

The Three Modes of Learning model (Pedler, Burgoyne et al. 1997), established three stages of a learning journey that SMEs can progress through. The stages within the journey ensures sustained success and contribute to the development of the internal and external environments which they are part of, i.e. "implementing", "improving" and "integrating". However, this model was considered limited for practical application within SMEs and required a mechanism to operationalise the concepts presented. Furthermore, to apply it to the adoption of NPD success factors, this mechanism must also provide knowledge and insights to direct learning efforts towards 'best practice' NPD.

While learning-by-doing (i.e. action learning) provided an appropriate mechanism for facilitating learning within SMEs, it too did not explicitly direct learning efforts towards 'best practice' NPD. To facilitate learning to support sustained NPD success, the SME must experience "critical incidents" that related to NPD. Furthermore, appropriate expertise must be available within the SME in the form of a mentor or coach to identify appropriate opportunities to learn and enable effective actions and reflections.

The F/W/C-P System clarified the relationship between three components of learning that influence practice and performance. This relationship supported the refined focus of the present research and highlighted that appropriate knowledge, capabilities and attitudes (i.e. organisational learning) were required influence and sustain organisational practice. However, the operation of this model presumes knowledge of 'best practice' NPD within the SME or at least access to appropriate knowledge.

Therefore the practical application of this model requires an additional mechanism to guide the definition of effective performance goals and provide a focus on NPD.

Audit tools and particularly maturity-based tools combined descriptive knowledge of 'best practice' with the identification of stages (or maturity levels) that guided improvements. By identifying incremental development stages, these models prioritised learning goals and could ensure the appropriate focus of limited resources within SMEs. However these models were typically very resource-intensive and were therefore inaccessible to SMEs. Furthermore many NPD related maturity-based models adopted a comprehensive focus on individual components of NPD such as project management (Ibbs 2000; Kerzner 2005), design(Moultrie, Clarkson et al. 2007) and supply chain management (Lockamy III and McCormack 2004). Existing models did not explicitly capture knowledge of all areas relating to successful NPD that were identified within the literature.

Therefore a need was identified for a new accessible model to facilitate learning within SMEs to support NPD. A new model was required to effectively captured knowledge and insights of all requirements of successful NPD and appropriately directed learning and implementation efforts to ensure sustained success. Therefore the development of a new model was the focus of further research.

It was established that this model should consider the strengths of the existing approaches that had been identified. It should:

1. Capture knowledge of good practice NPD
2. Identify a learning journey (e.g. incremental stages or levels)
3. Enable 'learning-by-doing', which was appropriate mechanism for learning within SMEs, and
4. Ensure a balance is achieved between knowledge, skills and attitudes in order to effectively influence organisational practice

5.3 The Logical Learning Model

A conceptual model, namely Logical Learning was developed with consideration to existing approached to organisational learning and the achievements of the NPD improvement project within Magal Engineering Limited. The model facilitates organisational learning within SMEs to support the implementation of NPD success factors for sustained success. Logical Learning advocates a bottom-up relationship between NPD success factors, akin to a logical progression of knowledge and capabilities within SMEs. Facilitated by action learning (Learning-by-doing) the model defines incremental development stages in a SMEs learning journey towards implementing critical NPD success factors for sustained success.

There were three stages in the development of Logical Learning, which are described in more detail in the following sections of this report:

Stage 1: The definition of a 'bottom-up' relationship between the components of NPD within SMEs that defined the learning journey

Stage 2: The identification of NPD success factors that captured existing knowledge.

Stage 3: The definition of a learning-by-doing element to operationalise the model for its application within SMEs.

5.3.1 Bottom-up Relationship within Logical Learning

With consideration to the achievements of the NPD improvement project within Magal Engineering limited and the literature, a "bottom-up" relationship was established within the model. This relationship identifies incremental stages of a SMEs journey towards implementing NPD success factors to effectively direct learning and improvements efforts.

Reflection of the Learning Outcomes of the NPD Improvement Project

Despite the organisational challenges identified 'learning-by-doing' (inherent in the action research methodology employed) during the NPD improvement project had led

to the development of a structured process approach to NPD and a strategy for project management within an SME. With consideration to the F/W/C-P System (Figure 5-2 The performance system), this performance outcomes was attributed to the SMEs understanding (i.e. focus), intention (i.e. will) and capability to implement NPD success factors amidst organisational challenges. This dictated the SME's learning journey and had proven that the organisation was more receptive to changes to NPD practice which related to structure, organisation and management as oppose to the more strategic areas of NPD. Consequently, in order to build on the learning achievements of the improvement project further stages of the learning journey needed to be identified and the implementation of further NPD success factors realised within the SME. This was achieved by considering the relationship between the elements of successful NPD.

The Relationship between Process and Strategy

It had been established that a business's NPD strategy is at the heart of all decision-making regarding NPD and ensured sustained success. Therefore, the ultimate goal of learning within SMEs would be the implementation of an effective strategy for NPD. This strategy would guide decisions including project selection and portfolio management with consideration to the organisation's resources and capabilities. Ultimately it would ensure the right products were developed by the organisation in a way that provided the desired value to both the customer and the business. Furthermore, the literature had established that the insights needed to aid decision-making and the activities that generated this knowledge were contained within the NPD process.

Therefore, there was a relationship between process and strategy. It was established that this relationship was typically defined as a downwards cascade. That is, strategic initiatives are often clustered into portfolios (groups) of projects for implementation. This hierarchy established the "strategic-portfolio-project" linkage which represented the dominant consensus within the literature. Drawing on the works of Turner(1999), Morris and Jamieson (2005) illustrate the 'strategic-portfolio-project' linkage and defined seven components in the hierarchy as illustrated in Figure 5-3 Linking Corporate and Project Strategy:

1. Business Strategy
2. Portfolio Objectives / Portfolio Strategy
3. Program Objectives / Program Strategy
4. Project Objectives / Project Strategy
5. Phase Objectives / Phase Strategy
6. Team Objectives / Team Strategy
7. Individual Objectives / Individual Strategy

For the purpose of this research, the hierarchy established by Morris and Jamieson (2005) was related to elements of NPD within SMEs as shown in Table 5-3 Strategy-Portfolio-Project hierarchy. Program objectives/strategy were omitted as SMEs were the focus of the present research and programs were typically characteristic of large businesses (Thiry 2007). Furthermore, it was established that the characteristics of a structured process approach to NPD encompassed three of the phases within the hierarchy, including: phase, team and individual objectives and strategy.

Therefore, a relationship between NPD strategy and NPD process was established and consisted of four components. This relationship was 'top down' and conformed to traditional thinking.

However, the researcher recognised that the NPD improvement project had so far successfully begun with learning and the implementation of a NPD process approach and strategy for project management. This 'bottom-up' approach reflected the SMEs receptiveness to changes to their NPD practices and it was now understood that this related to their understanding, intention and capability to implement NPD success factors. Therefore, in order to build on the research achievements so far, while contrary to traditional thinking, a 'bottom-up' relationship between NPD strategy and NPD process was considered in establishing further stages of the SME learning journey towards implementing NPD success factors.

Table 5-3 Strategy-Portfolio-Project hierarchy

Traditional Components within the Hierarchy (Morris and Jamieson 2005)	**Equivalent Components relating to NPD within SMEs**
Business Strategy	NPD Strategy
Portfolio Objectives and Strategy	Portfolio Management
Program Objectives and Strategy	
Project Objectives and Strategy	Project Management
Phase Objectives and Strategy	Structured Process Approach
Team Objectives and Strategy	

The potential validity of a bottom-up relationship between the components in the 'strategy-portfolio-project' hierarchy is supported by Morris and Jamieson (2005) who identify that not all strategy implementation is just downwards. Management information and action can also translate up from project to portfolio to strategy. The authors argued that this is specifically true when considering the management of resources, which is a fundamental responsibility of project management and a critical link between strategy and project. With consideration to this insight, resource management was established as an intermediary component within a bottom-up alternative to the strategy-portfolio-project hierarchy. Within the equivalent hierarchy for NPD within SMEs (Table 5-3 Strategy-Portfolio-Project hierarchy) this components was linked to project management. Therefore a 'bottom-up' relationship was established between components relating to NPD within SMEs, which included (
Figure 5-4 NPD Strategy-Portfolio-Project Hierarchy):

1. Structure process approach
2. Project Management
3. Resource Management
4. Portfolio Management
5. NPD Strategy

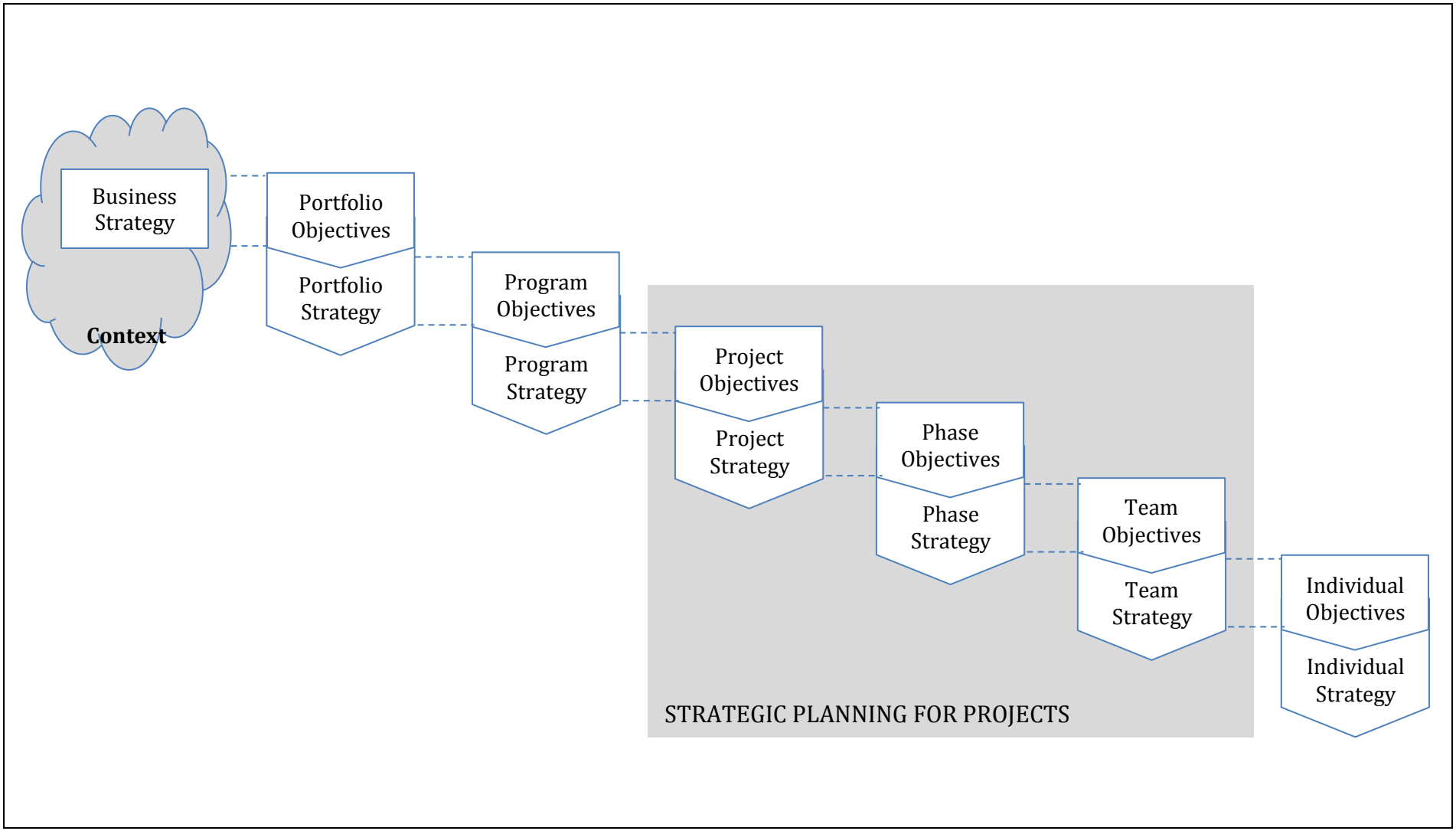


Figure 5-3 Linking Corporate and Project Strategy
Source: The Handbook of Project-Based Management, 2nd ed. J.R Turner (1999), adapted by Morris and Jamieson (2005)

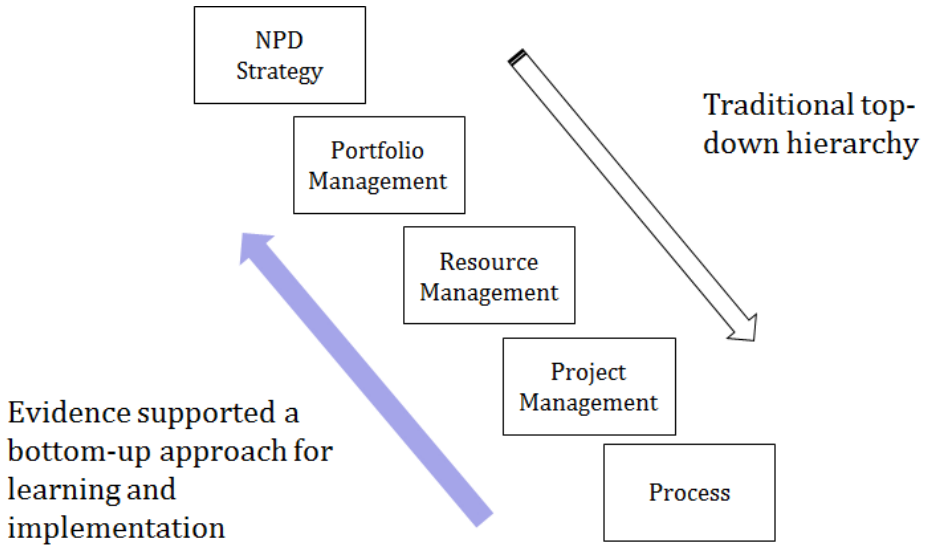


Figure 5-4 NPD Strategy-Portfolio-Project Hierarchy

The origins of a conceptual model for were formed. Building to the learning achievements of the NPD improvement project, the bottom-up relationship between the components was used to define incremental stages within the model that dictates of an SME's learning journey towards implementing NPD success factors. The relationship between the components identified a priority which was comparable to capability maturity levels. In this way the model directs learning and implementation by identifying intermediary points between NPD process and NPD strategy.

5.3.2 Identification of NPD Success Factors

The incremental stages of the model were related to existing knowledge of five categories of critical NPD success factors, which had been identified earlier in this report (Table 2-3 New Product Development Success Factors). The researcher proposed that the five categories would be captured within the stages of the model as identified below. In this way the model would provide a 'simple' identification of critical NPD success factors to enable insight into the requirements of successful NPD and to support the development of organisational knowledge within SMEs.

1. *Strategy* – the company's total new product strategy. This was the most significant factor determining NPD success and involved effective portfolio management to ensure consistent and continuous success. This factor was captured in the NPD Strategy and Portfolio Management components of the model

2. *Process* - the company's NPD process and specific activities within this process. This factor referred to the existence of a structure 'process approach' to NPD and was captured in the NPD Process component of the model.

3. *Organisation* – the way projects are organised. This factor referred to the use and quality of a cross-function approach to NPD with effective leadership and management for NPD. This factor was captured in the Project Management and Resource Management stages of the model.

4. *Culture* – the company's internal culture and climate for innovation. This referred to characteristics ways of working within an organisation. It involved the principles and attitudes shared by the people in an organisation and it was established that the culture should promote, support and reward creativity and innovation. This factor was required to be reflected in all elements of NPD and therefore was captured as encompassing all other components of the model.

5. *Commitment* – senior management's involvement with and commitment to NPD. Like culture, this factor was required to be reflected in all elements of NPD. It involved ensuring senior management involvement in the NPD Process, the availability of appropriate resources and communicating a commitment to NPD through a NPD Strategy. Therefore this factor was also captured as encompasses all other components within the model.

5.3.3 Learning-by-Doing Mechanism to Facilitate Learning

The model was operationalised by 'learning-by-doing', which was established as an appropriate mechanism for facilitating learning and development within SMEs (as discussed in section 4.2.3. within this report). This mechanism had also been

established in practice as appropriate for supporting the implementation of NPD success factors within an SME during its application in the development of the MBMS at Magal Engineering Limited. However, further consideration of this approach had identified further factors that determine the achievements of this approach:

1. "Critical incidents" that were related to NPD in order to provide the appropriate opportunity for learning.
2. The use of a coach/mentor with the expertise to facilitate action and reflection i.e. learning-by-doing.

Moreover, it was determined that the model would create "critical incidents" relating to NPD by taking advantage of the bottom-up relationship between its components and using each incremental development stage to generate evidence of the necessity of subsequent stages. This evidence can be gathered by implementing visual management strategies such as the Master Product Plan (MPP) that was developed previously during the NPD improvement project within Magal Engineering Limited. The following steps were defined as a guide to the objectives of 'learning-by-doing' at each incremental development stage within the model:

Step 1: A NPD Process is implemented and includes a strategy for project management.

Step 2: A strategy for project management is implemented and highlights any resource constraints to establish a need for resource management.

Step 3: A strategy for resource management is implemented and highlights any portfolio constraint to establish a need for portfolio management.

Step 4: A strategy for portfolio management is implemented and highlights a need to establish an overall strategy for NPD within the business.

Step 5: A NPD strategy is implemented and identifies business objectives for sustained success

Furthermore, it was determined that the model would promoted the use of a coach/mentor to facilitate learning-by-doing within SMEs. The following skills and

attributes that this individual should possess were identified as defined by the World Institute for Action Learning to guide SMEs in selecting a coach (Marquardt):

- *Ability to ask questions* – this refers to the ability to ask reflective questions in a supportive manner in order to create possibilities for significant learning and breakthrough actions.
- *Courage and authenticity* - in order to ask the "tough" questions to persons at all ranks or expertise achieve results.
- *Timing in intervention* – to ensure the best opportunity for learning e.g. when there is sufficient experience and data.
- *Confidence and trust in the process and the people in the group* - this includes: confidence in the action learning process, an enthusiasm for learning and a commitment to help the group.
- *Values of humility, integrity, patience and openness* – the coach should be cognizant of how his/she values and actions affect the group and the learning process[3]
- *Strong coordination and planning skills* - to fulfil addition roles of: teacher, administrator, advisor and champion of learning initiatives
- *Deep listener*–the coach need to possess strong listening skills which enables a holistic view of development and learning.
- *Strong commitment to learning* - the urgency of problems can overwhelm the importance of learning therefore the coach must have a strong focus on learning.
- *Positive attitude towards group members* - this refer to a respect for people and a concern for their well-being. The coach wants to see people succeed in their project and learning from doing so.
- *Self-awareness and self-confidence* -the coach needs to be cognizant of his/her strengths and limitations. Self-confidence enables him/her to be authentic and resilient.

[3]Action learning follows a process which is analogous to the action research process defined in Chapter 4 – Research Methodology and involves working through stages of inquiry, action and reflection (Freedman, A. M. (2010) Using Action Learning for Organisational Development and Change. WIAL-Authored Articles

5.4 Summary of the Development of Logical Learning

Four existing approaches to learning were reviewed in order to develop mechanism that overcame organisational challenges and facilitated the implementation of NPD success factors within an SME. As a result the requirements of a new approach were defined, which would appropriately facilitate learning within SMEs to support the implementation of NPD success factors and sustained success. It was established that this new approach should:

5. Capture knowledge of good practice NPD
6. Identify a learning journey (e.g. incremental stages or levels)
7. Enable 'learning-by-doing', which was appropriate mechanism for learning within SMEs, and
8. Ensure a balance is achieved between knowledge, skills and attitudes in order to effectively influence organisational practice

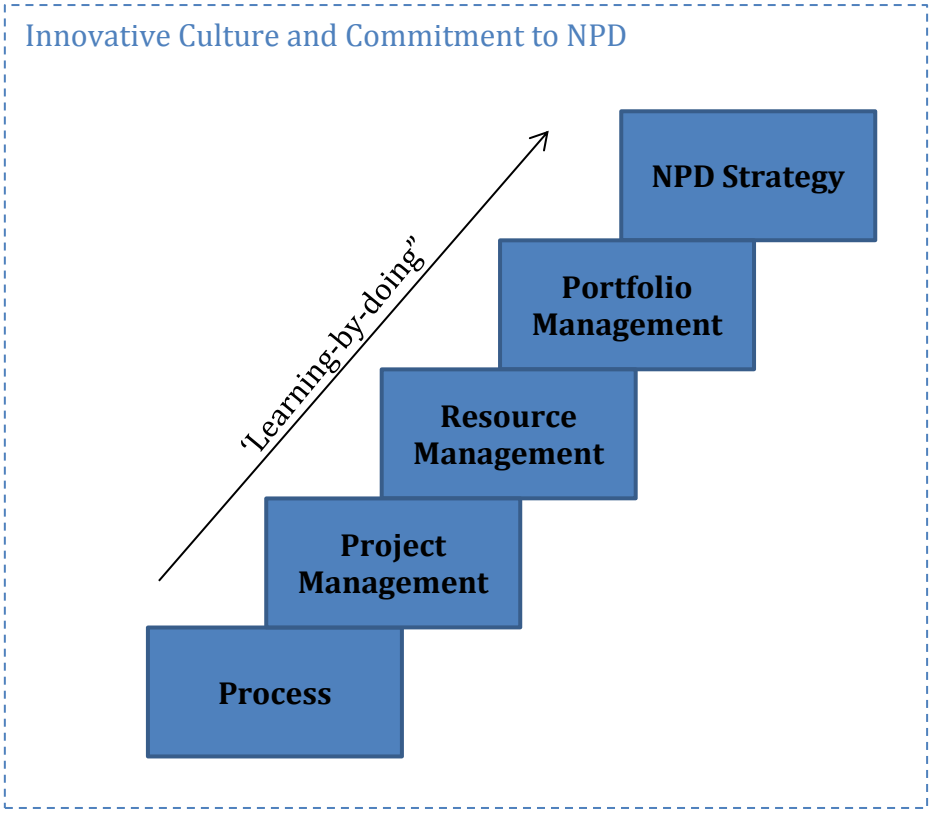


Figure 5-5 the conceptual model - Logical Learning

Therefore, a conceptual model was developed and is illustrated in Figure 5-5 the conceptual model - Logical Learning. Logical Learning advocates a bottom-up relationship between NPD success factors, akin to a logical progression of knowledge and capabilities within SMEs. Facilitated by 'Learning-by-doing' (Action Learning) the model defined incremental development stages in a SMEs learning journey towards implementing critical NPD success factors for sustained success. The model includes the following elements:

- A 'Simple' identification of critical NPD success factors which supports the development of knowledge and insights of the requirements of success
- An original "bottom-up" relationship between the critical success factors that identifies incremental stages in an SME's learning journey towards implementing and improving NPD practices.
- Learning-by-doing, which provides the mechanism which operationalises the model for use within SME.

6 Application of the Logical Learning Model

The third and final research objective was to apply the Logical Learning model to an SME context in order to demonstrate its validity and value. This was achieved during the second cycle of action research (ARC2) through active engagement in a regional innovation project in the West Midlands, UK.

ARC2 took place in collaboration with the Manufacturing Advisory Service, West Midlands (MAS-WM), who were a government funded organisation aimed at supporting manufacturing businesses in the West Midlands region. In September 2009, following the success of a pilot New Product Development (NPD) program, MAS-WM commissioned a collaborative project to develop a comprehensive NPD offering for the organisation to further support innovation within SMEs in the region, namely the New Product Development Gateway process (NPD Gateway). MAS-WM provided an appropriate context for the research to investigate the potential application of the model and access its validity for SMEs. The organisation focused on supporting NPD within a range of SMEs and so far research efforts had focused on a single organisation. Hence the collaborative project provided a broader context for the research that enabled the generalisation of findings to be explored.

In collaboration with MAS-WM the researcher lead the development and implementation the unique NPD Gateway process that supports predominantly small-medium sized enterprises (SMEs) in developing and introducing new product ideas to the marketplace. The learning gained from the exploratory study that had led to the conception and development of the Logical Learning model was transferred during this stage of the research, such that the model was implemented within the NPD Gateway process. In this way the researcher contributed to an extension of the value of the process. The process has been developed not only to support the commercialisation of SMEs new product ideas but also facilitate organisational learning within participant companies. In 2010 Logical Learning was recognised as a key component of the strategy of the MAS-WM NPD Gateway Process that supported participant's (SMEs) adoption of

NPD success factors and ensured that they were better equipped to sustain NPD success.

During the NPD Gateway project actions have been taken to implement the conceptual model - Logical Learning - within the NPD Gateway process. Evidence was generated to demonstrate the innovativeness of the new process that was developed and its applicability and value to and range of SMEs.

6.1 The Development of New Product Development Gateway

New Product Development Gateway (NPD Gateway) was developed by way of a collaborative project involving the Manufacturing Advisory Service in the West Midlands, UK (MAS-WM), WMG, The University of Warwick, UK and independent consultants with expertise in NPD. The researcher was part of a core project team who were responsible for all areas of the process development. The team worked through six stages of development that are summarised in Figure 6-1 Stages of the development of NPD Gateway:

- *Stage 1: Review of the existing process* - key stakeholders were engaged with to review the exiting pilot program and identify areas for improvements. It was identified that no formal process had been document to facilitate business innovation support for SMEs. The improvements identified were targeted during the development of the NPD Gateway process.
- *Stage 2: Preliminary process development* - the structure of the process was defined. A 'Stage-Gate' approach was adopted and six stages were outlined in scope.
- *Stage 3: Detailed process development* - the purpose and objectives of the process were confirmed. Detailed elements of the process was defined and documented within the NPD Gateway process manual. During this stage the Logical Learning model was introduced and implemented within the process. The process was officially launched on 1st April 2010.

- *Stage 4: Process implementation* – a workshop that was held at the University of Warwick on the 22nd April 2010 to support the implementation of the process. The process currently supports over 40 companies within the West Midlands, UK.
- *Stage 5: Dissemination and evaluation* – the process was disseminated to practitioners and academics during a series of planned events. Initial case study evaluations indicated the value of the new process.
- *Stage 6: Final process development* - a final development stage was commissioned to implement further improvements to the process. During this stage research efforts facilitated the achievement of ISO 9000:2008 accreditation of the process.

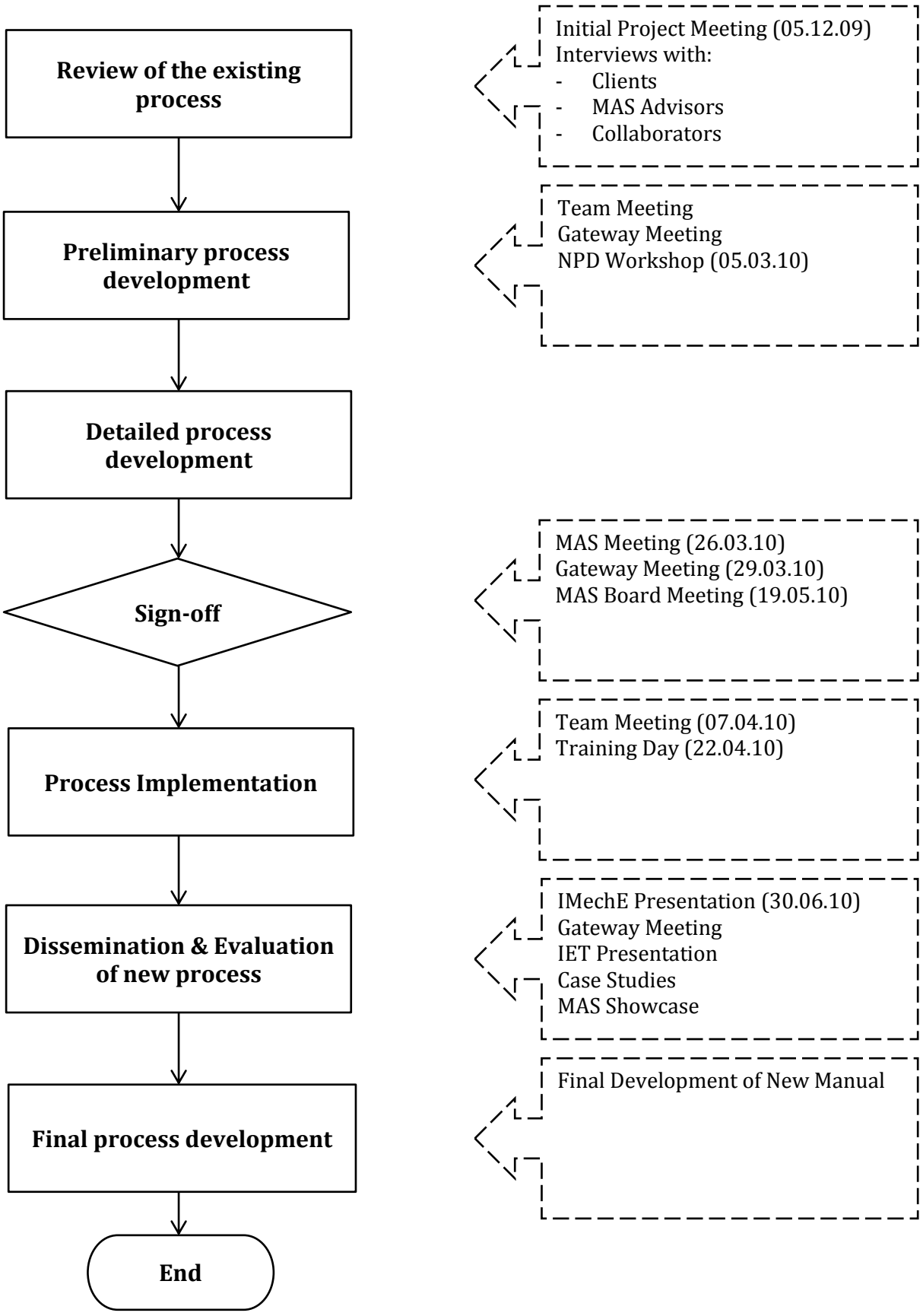


Figure 6-1 Stages of the development of NPD Gateway

6.1.1 The Implementation of the Logical Learning Model within the Process

During the development stages the researcher introduced and implemented the conceptual model – Logical Learning - within the NPD Gateway process. The implementation of the model extended the value of the MAS-WM offering. Fundamentally, NPD Gateway was viewed as a process that could not only support the commercialisation of new product ideas within the West Midlands, UK (as it was originally conceived to do). It was also viewed that NPD Gateway could provide a mechanism for facilitating 'learning-by-doing' through participation in the process.

The model provided a framework that directed learning and the development of knowledge, skills and attitudes to support the implementation of critical NPD success factors. This was to ensure participants were better equipped to sustained NPD success following involvement in the process. Where required the elements of the model (as defined in section 5.3 – The Conceptual Model) were tailored to its application within NPD Gateway.

The Stages of the Model

The five stages of the Logical Learning model captured the critical success factors for NPD. It was agreed that promoting an understanding of these success factors within participant SMEs was important. Moreover, the 'simple' identification of the factors established by the definition of the incremental development stages of the model was appropriate to support the development of participant's knowledge. Therefore this element of the model was not adapted for its application within the NPD Gateway process.

The model identified NPD success factors for a wider context than was previously explicitly promoted by MAS-WM. That is, a focus on NPD strategy and NPD portfolios. Therefore, the implementation of the model extended the scope of the NPD offering. MAS-WM typically supported SME and it had been recognised that these types of businesses may not be committed to achieving long-term success through NPD. SMEs are characterised as having "diverse motivations" (Storey and Greene 2010) for

innovation and typically have a moderate orientation for growth (refer to section 2.2 – The Importance of Innovation within SMEs).

By promoting the model in its entirety within NPD Gateway the researcher enabled an increased recognition within MAS-WM of the importance of sustained NPD success within SMEs. Furthermore it supported a need to encourage business development and growth within this business sector, which was important for economic development and growth.

The Learning Journey

The Logical Learning model promoted a "bottom-up" relationship between NPD success factors and defined five incremental stages that directs learning and the implementation of good NPD practices. Namely: NPD process, project management, resource management, portfolio management and NPD strategy. In Section 5.3 of this report it was proposed that the migration between the stages i.e. the learning journey, is facilitated by making each stage visual. Such that at each stage, evidence is generated of the necessity of the subsequent stage. This effectively created the "critical incidents" that provided the opportunity for 'learning-by-doing'. However, for its application within NPD Gateway, which was a business support programme, the researcher adapted this element of the model.

Within NPD Gateway, migration between the first three stages of the model was facilitated through participation in the NPD Gateway process, which was developed to provide a 'best practice' approach to NPD. Critical NPD success factors were embedded within the process, such that participants were expected to follow a structured process approach to NPD and manage their NPD project and the necessary resources. This effectively ensured they progressed through the stages of: NPD process, project management and resource management.

NPD Gateway was developed to encourage migration to the subsequent stages of the model during the process i.e. portfolio management and NPD strategy. This learning would be facilitated through a series of NPD workshops that are currently planned for

further development. Therefore, as oppose to making each stage visual to generate evidence that supported migration through the stages, the NPD Gateway process itself was developed to provide "critical incidents" and the opportunity for appropriate 'learning by doing'.

Mentoring of Participant Companies

The final element of the Logical Learning model is the 'learning-by-doing' mechanism that operationalises the model. This was achieved through the use of an action learning coach, who identified "critical incidents" and facilitated the development of appropriate knowledge, skills and attitudes.

Within NPD Gateway action learning and coaching was enabled by 'one-to-one' mentoring of participants by experienced product innovation advisors. The advisors had all-round NPD expertise and experience of working with SMEs. The researcher defined that the mentor-participant relationship would facilitate collaborative learning based on the activities within the NPD Gateway process. Inherently these activities related to critical NPD success factors.

Moreover, the role of project manager during the NPD Gateway process was allocated to the participant (SME) and supported by the advisor to ensure the transfer of 'best practice' knowledge, skills and attitudes. The researcher defined that the project manager was responsible for the following activities, which relate to the first three stages of the Logical Learning model:

- Defining the goals and objectives which guide the development of the product e.g. the product offer and key performance indicators (KPIs)
- Establishing and organising tasks during each stage of the NPD process
- Producing an updated timing plan to the Gateway Panel at each Gateway Meeting
- Establishing, leading and organising project resources (internal and external)
- Establishing and monitoring project spend and funding requirements.
- Monitoring and reporting project progress to the Gateway Panel

The 'learning-by-doing' element of the model was further enabled during the process in the definition of Gateway Meetings, which were held by a NPD Gateway Panel. The panel consisted of an experienced cross-functional team who the SME participant (and mentor) would meet with at regular interval during the process. The meetings aimed to assess the participant's project, sanction resources and provide guidance and sign-posting to further expertise, which supported the successful progression of the project. This element of the process was developed to provide access to a wide variety of NPD expertise that not only supported the development of participant's new product ideas but also their learning of the requirements of NPD success.

Further details of the roles and responsibilities of the participant, advisor (mentor) and NPD Gateway panel are included in the research portfolio within Submission 4 – NPD Gateway: Process Manual.

The Logical Learning model has been implemented within NPD Gateway and establishes the learning element that is core to the process. This element is at the heart of the successful development of participant's knowledge, skill and attitudes, which ensures they are equipped to sustain NPD success. The model now underpins the strategy and value of the MAS-WM NPD offering. In a promotional booklet the Innovation Team Leader for MAS-WM, Roy Pulley, commented on the nature and significance of this learning element:

"the 'learning-by-doing' for participating companies has transferred knowledge helping to embed the critical NPD success factors into their organisations….The MAS-WM Gateway Process supports clients in making innovation the strategic imperative for their business. By collaboratively developing in-company capabilities to develop a NPD process, manage projects and resources, the companies are closer to successfully executing a portfolio of NPD projects. These product commercialisations will continue to raise their global competitiveness and contribute to the UK economy"

6.1.2 The New Product Development Gateway Process

The New Product Development Gateway process (NPD Gateway) is a unique business support offering provided by MAS-WM. It has been developed to support predominantly SMEs in developing new product ideas and introducing them to the marketplace.

The process considers the characteristics and constraints of SMEs, including: limited internal finance and limited access to specialist cross-function resources. It provides four key elements of business support to participant companies:

- A structured new product development (NPD) process and methodology to mitigate technical and commercial risk throughout the development activities up to commercialisation
- 'One-to-one' mentoring by experienced product innovation advisors and sign-posting to technical and commercial expertise and resources
- Matched funding to mitigate the cost of all relevant externally provided resources
- An 'over-arching' monitoring and control of the product development activities from a widely experienced NPD Gateway Panel

The overall purpose of NPD Gateway was defined as follows:

"To raise the competitiveness of the UK's manufacturing SMEs by increasing the rate of product innovation"

The process supports the commercialisation of new products and learning within participant companies. The four core objectives of the process have been defined as follows:

1. To increase the rate of successful commercialisations of NPD projects, predominantly within Manufacturing Businesses.
2. Draw on the unique breath of experience of MAS-WM's Advisors and the NPD Gateway Panel to support and mentor Clients through an appropriate Stage-Gate approach to NPD.

3. To promote an understanding within Clients of successful NPD as a complete business process.
4. Encourage and support the embedding of the NPD Gateway Process within Client Businesses.

Based on the Stage-Gate methodology (Cooper 2001) a 'Gateway' approach was defined, and is driven by a NPD Gateway Panel. This approach describes how participant projects are subjected to examination by the Panel at key points (gates) within the process. The Panel examine client projects against pre-determined criteria, which are defined within task and deliverables lists. This ensures on-going investment is managed and potential success / failure of the new product idea is recognised as early as possible. Based upon realising the criteria further resources and funding is allocated to client projects. An overview of the structure of NPD Gateway is illustrated in Figure 6-2 NPD Gateway process flow diagram.

Key documents that the researcher developed to support the process include but are not limited to the follow:

1. *Task and Deliverables List* (Appendix 2) – the list identifies the tasks and deliverables for each stage of the process. In order to promote an understanding of the business areas involved in NPD, the tasks have been grouped into work streams which run concurrently through each stage of the process.

2. *Gate Paper and Diagnostic* (Appendix 3) – this has been the main document that governs the process and has been used at Gateway Panel meetings. Overall the document:

    - Captured a comprehensive overview of individual project status including: estimated budgets, timings, participant requirements and the NPD Gateway Panel decisions
    - Adapted the concept of readiness levels to include an assessment of risk in the form of a 'project readiness level'.

- Included a NPD diagnostic, which provided a mechanism for monitoring the development of projects and participant capabilities across six areas: business, market, product, manufacturing, finance and knowledge transfer.

The MAS-WM New Product Development (NPD) Gateway process was officially launched on 1st April 2010. The researcher is the author of a full comprehensive description of the NPD Gateway process that is included in the research portfolio in Submission 4 – NPD Gateway: Process Manual.

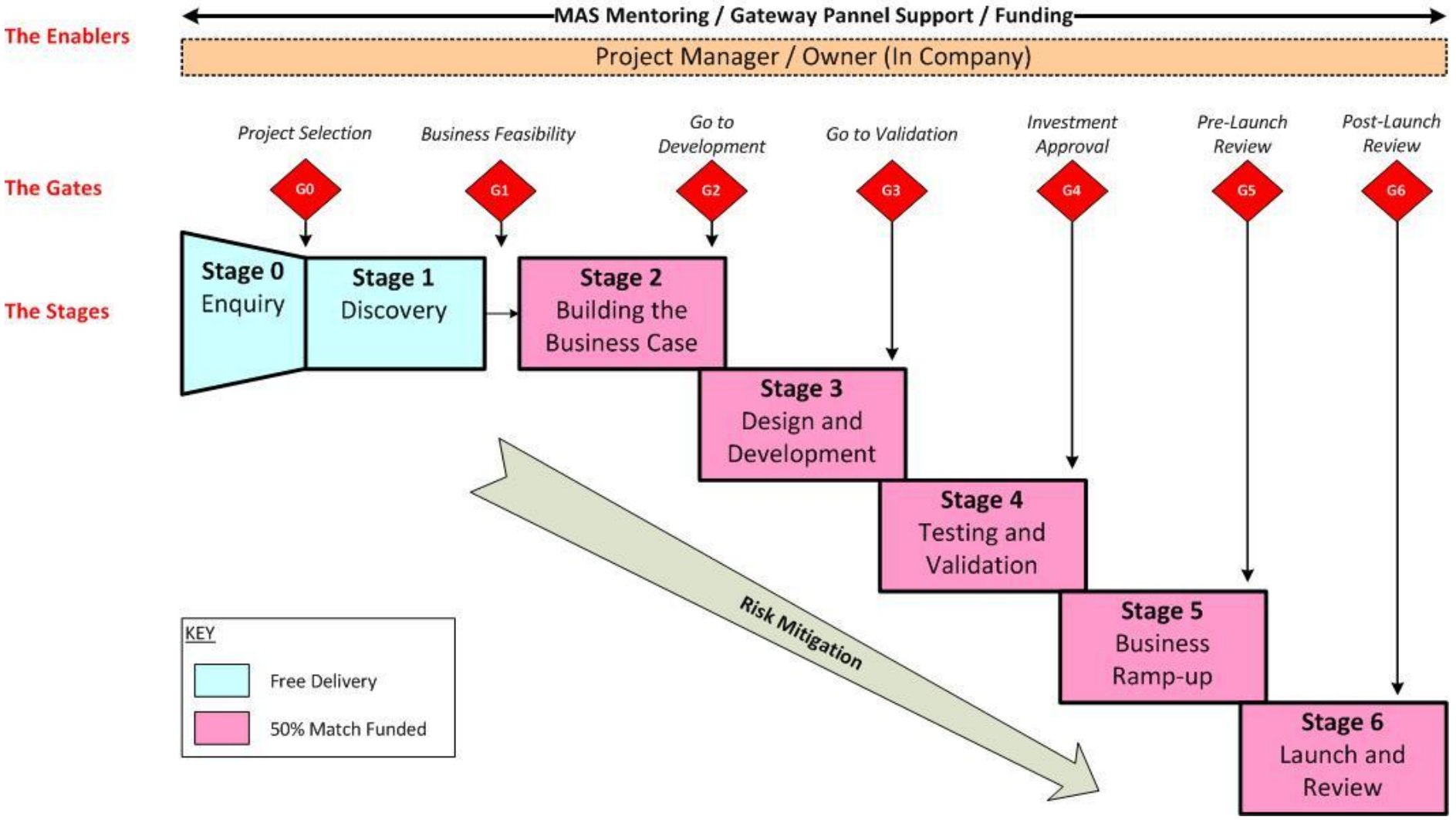


Figure 6-2 NPD Gateway process flow diagram

6.1.3 Dissemination and Case Study Evaluation

Following the launch of the NPD Gateway process, the researcher was actively involved in a series of events and activities that were conducted in order to disseminate and evaluate the process.

- *Dissemination within Engineering Institutes* – the process was presented at the Institute of Engineering and Technology (IET) on 22nd April 2010 and the Institute of Mechanical Engineers (IMechE) on 30th June 2010. These presentations highlighted the uniqueness of the process and the need for similar NPD offering that supported learning and capability development within SMEs within other regions of the UK.

- *Case Study Evaluations* - A PR company was commissioned to support the development of a promotional film and booklet, which showcased participant's success stories. Data was gathered on participant's perceptions of the process which enabled case study evaluations. Participant's perceived that the value of the process was in areas including: mentoring, facilitation of learning, support in decision-making and risk mitigation. Some of the participant comments included:

  - *"MAS has improved my understanding of manufacturing and product development"* – Stephen Gilmore, Chairman, Eco-Drive Systems Ltd

  - *"The programme has given structure and definition and taught us a way of doing things systematically, something we would not have done without their help"* – Graham Corfield, Managing Director, Aviramp

  - *"The NPD programme team was able to identify risks, offering support at every stage of development and manufacture"* – Peter Neath, Director, Grillstream Technology Ltd

The final case study booklet is included in Submission 4 – NPD Gateway: Process Manual. It can also be accessed via the following link.
http://maswmsupplierdatabase.co.uk/sites/default/files/MAS-NPD-Gateway.pdf.

The final promotional film can be viewed by following the link:
http://www.youtube.com/watch?v=cIZfHjBMAvs

These events enabled an informal evaluation of the value of the NPD Gateway process. Subsequently, the research also formally validated the application of the Logical Learning model as described in the following section of this report.

Further details of the development of NPD Gateway are provided in the research portfolio in Submission 3: NPD Gateway: Process Development.

6.2 Summary of the Application of Logical Learning

In order to apply and validate the Logical Learning model, the researcher engaged in a regional innovation project in the West Midlands, UK. In collaboration with the Manufacturing Advisory Service, West Midlands (MAS-WM) the unique New Product Development Gateway Process (NPD Gateway) was developed. The learning gained from the exploratory study at Magal Engineering Limited was transferred such that the Logical Learning model was fully implemented within NPD Gateway.

The process has been developed not only to support the commercialisation of SMEs new product offering, but also to facilitate organisational learning to facilitate their implementation of NPD success factors and ensure they are better equipped to sustain success.

Logical Learning now underpins the strategy and value of the NPD Gateway process. The implementation of the model within the MAS-WM process provides an appropriate context in which to evaluate the concepts advocated by the model.

7 Validation of the Logical Learning Model

The final stage of this research was the formal validation of the Logical Learning model. A summative evaluation was conducted to formally validate the significance of the application of Logical Learning, within the New Product Development Gateway process (NPD Gateway). To ensure improved the quality of evidence gathered and to strengthen validity of research outcomes, appropriate evaluation models were investigated. As a result the Kirkpatrick's Four-Levels model for learning evaluation (Kirkpatrick 1959; Kirkpatrick 1998) was used to structure the evaluation of NPD Gateway. The evaluation focused on participant learning targeted by the implementation of Logical Learning and determined a chain of impact from participation in the NPD Gateway process to the development of knowledge, skills and attitudes (i.e. participant learning), to the successful implementation of NPD success factors and organisational practices that support sustained success.

7.1 NPD Gateway Evaluation of Participant Learning

The purpose of the evaluation was defined as follows:

"To validate the significance of NPD Gateway in facilitating organisational learning within SMEs to support the implementation of NPD success factors and sustain success"

To this end three evaluation objectives were defined:

1. To assess the effectiveness of NPD Gateway
2. To assess the development of organisational: knowledge, attitudes and capability as a result of NPD Gateway. This assessment focused on the success factors defined within the five developmental stages of the Logical Learning model:

- NPD process,
- Project management
- Resource management
- Portfolio management
- NPD strategy

3. To assess the impact learning has had on organisation practice e.g. the implementation of critical NPD success factors.

7.1.1 Justification of the use of The Four-level Model for Evaluation

An initial review of evaluation literature determined that the evaluation of NPD Gateway was a summative evaluation. Summative evaluations aim to determine the overall effectiveness of a program or project (Bryman and Bell 2007; Stufflebeam and Shinkfield 2007; Gray 2009). It was recognised that the purpose and objectives of the present evaluation focused on establishing the value of the application of the Logical Learning model within NPD Gateway, as oppose to a more "improvement-oriented" evaluation that is referred to as a formative evaluation. The identification of the summative nature of the evaluation provided the focus for a further review of evaluation models and approaches to those that supported summative studies. Kirkpatrick's Four-level Model for evaluation was identified as the most widely used for classifying evaluations (Tamkin, Yarnall et al. 2002). The model was justified as an appropriate model to support the evaluation of NPD Gateway.

The Four Levels Model for evaluation (Kirkpatrick 1959; Kirkpatrick 1998) is a summative evaluation model that provides a comprehensive scope for evaluating learning and development programs i.e. *"programs designed to increase knowledge, improve skills and change attitudes"*. NPD Gateway was considered to be a learning and development program. Through the implementation of Logical Learning it had been developed to facilitate learning, which is the development of: knowledge, skills and attitudes, in order to support the implementation of NPD success factors within SMEs. Furthermore, it was the learning element of NPD Gateway that was the focus of the

evaluation. The Four Levels Model identifies four areas that are important for the evaluation of such programs (Kirkpatrick and Kirkpatrick 2009):

- Level 1 - Reaction , to what degree participants react favourably to the learning event
- Level 2 – Learning, to what degree participants acquire the intended knowledge, skills and attitudes based on their participation in the learning event.
- Level 3 – Behaviour, to what degree participants apply what they learned during the training when they are back on the job (i.e. within their organisation)
- Level 4 – Results, to what degree targeted outcomes occur as a result of the learning event and subsequent reinforcement

Some authors have proposed alternative evaluation models, which appear to further develop the Four Levels defined, to include elements before the assessment of reaction (level 1) and after the assessment of organisational results (Level 4). This has been done to aid the design of the 'learning event' and to collect additional measures of return on investment. However these elements were outside the scope of the present evaluation, which focused on assessing learning in order to determine the value of the Logical Learning model.

Additionally, it was determined that alternative models did not dispute the importance of the scope of the original Four-levels for the evaluation of learning and development programs. All models were common in that they tacitly base themselves on an assumption that is established within the Four Levels Model. That is, an assumption that there is a "chain of impact from a development event or process to individual learning and to organisational/societal impact" (Tamkin, Yarnall et al. 2002). This assumption supported the objectives of the present evaluation, which effectively sought to assess the chain of impact from SME participation in NPD Gateway, to SME learning, to an impact on organisational NPD practices (Figure 7-1 Chain of impact assessed).

Figure 7-1 Chain of impact assessed

It was recognised that the Four Levels Model focused on 'individual learning' of participants and not organisational learning. However, this was considered acceptable to provide an indication of 'organisational learning' as a result of NPD Gateway, as the process of individual learning has a significant impact on organisational learning (Wang and Ahmed 2003). Learning starts from individuals before it is transferred to organisations. Furthermore, the SMEs that participated in NPD Gateway were typically micro business (i.e. had less than 10 employees) and it was the business owners that took part in the process. Therefore, it was considered that an evaluation of the individual learning of the business owner could be considered representative of the organisation's learning.

Hence, Kirkpatrick's Four Levels Model for learning evaluation provided a justified approach to structure the evaluation of NPD Gateway.

7.1.2 Evaluation Design

The evaluation was structured into four areas, which built on a chain of evidence that linked organisational results to participation in the NPD Gateway process. The structure of the evaluation is provided in Table 7-1 Structure of the evaluation

1. *Level 1 –Reaction Evaluation*:

   The overall purpose of Level 1 – reaction evaluation was to evaluate how favourable participants SMEs reacted to NPD Gateway. This level provides a measure of customer satisfaction to determine what learners felt about the process (Kirkpatrick 1998). Favourable reactions are considered critical to the success of training programs, as people learn better when they accept training willingly and react positively to the form it takes (Carnevale and Schultz 1990).

The reaction evaluation of NPD Gateway provided an overall assessment of the effectiveness of the process. The purpose of the data was to establish what participants felt about the elements of the process. Drawing on the works of Lee and Pershing (1999) a comprehensive set of dimensions were assessed. This ensured the multiple-elements of NPD Gateway were captured during the evaluation.

2. Level 2 –Learning Evaluation

The overall purpose of Level 2 – learning evaluation was to evaluate what participants had learned as a result of the NPD Gateway process. The evaluation of learning considered (Kirkpatrick 1998):

- What knowledge was learned
- What skills were developed or improved
- What attitudes were changed

The learning evaluation of NPD Gateway provided an assessment of the knowledge skills and attitudes regarding the critical success factors that were targeted during the process. These success factors were captured in the developmental stages of the Logical Learning model. Namely: NPD process, project management, resource management, portfolio management and NPD strategy. Learning statements were developed to describe the learning targeted:

- Knowledge statement described an understanding of the requirement of each success factor.
- Skills statements described the ability to develop and implement each success factor within the organisation.
- Attitude statements described a willingness/intention to implement each success factor.

The evaluation explicitly enabled a retrospective pre-assessment of participant learning prior to entering the NPD Gateway process and an assessment of learning as a result of entering the process. This enabled a measure of the extent to which the NPD Gateway process had facilitated learning.

Table 7-1 Structure of the evaluation

Level 1 Reaction Evaluation *Overall purpose:* to evaluate how favorable participants reacted to NPD Gateway		
Dimension Assessed	**Purpose for the Evaluation of NPD Gateway**	**NPD Gateway Evaluation Questions**
Program Objectives/Content	To evaluate the content and four objectives of the program: 1. Increase the rate of successful commercialization's of NPD projects, predominantly within manufacturing businesses 2. Draw on the unique breadth of experience of MAS-WM Advisors and the NPD Gateway Panel to support and mentor clients through an appropriate Stage-Gate approach to NPD 3. Promote an understanding within clients companies of successful NPD as a complete business process 4. Encourage and support the embedding of the NPD Gateway process within client businesses	• Please indicate the appropriateness of the program to support new product development. • Please indicate the appropriateness of the program to support the requirements of small-medium sized businesses such as yours • To what extent has the program increased the rate of the successful commercialization of your new product development project? • To what extent has the program provided appropriate support/mentoring to you during your new product development project? - Are there any skills or capabilities missing within the program? • To what extent has the program promoted an understanding of NPD as a complete business process? • To what extent has the program supported the embedding of the NPD Gateway process within your company?
Logistics / Administration	To evaluate the smoothness and effectiveness of the logistical and administrative aspects of the program.	• How efficient is the application process to enter the program? • How efficient is the contracting process during the program?
Program Materials	To determine the effectiveness, efficiency, and usefulness of the NPD Gateway Process documentation i.e. Process	• How useful is the NPD Gateway Manual in clarifying the requirements of program?

	Manual and Gate paper and diagnostic	• How useful is the Gate Paper (and diagnostic) in reporting project progress and capturing next steps?
Delivery Methods / Technologies	To judge the appropriateness and effectiveness of the program delivery methods.	• How effective are meeting between you and your MAS Advisor? • How effective are meeting between you and recommended subcontractors / delivery partners? • How effective are meeting between you and the Gateway Panel?
Instructor/Facilitator	To rate the ability, preparation, and effectiveness of the MAS Advisor and Gateway Panel in leading the program.	• Please rate the quality of the knowledge of your MAS Advisors • Please rate the quality of the leadership capability of your MAS advisor • Please rate the knowledge of the Gateway Panel
Instructional Activities	To evaluate the appropriateness and helpfulness of the activities undertaken during NPD Gateway	• How useful are the activities / actions that you are required to complete during the program?
Program Time/Length	To assess the timeliness of NPD Gateway	• How appropriate was the time taken to progress through the stages of the program.
Planned Action/Transfer Expectation	To evaluate the participants plans/expectations and anticipated barriers for applying the content of NPD Gateway	• Do you plan/expect to apply any of the elements of the program with your business? - If yes please specify what elements you plan to implement. • Do you anticipate any barriers to the application of elements of the program within your business? - If yes please specify
Overall Evaluation	To determine overall participant satisfaction and feeling about NPD Gateway	• How satisfied are you with your experience of NPD Gateway? - Please add any further comments to support your assessment.

Recommendations for Program Improvement	To receive recommendations for improving NPD Gateway	• Please comment on how we could improve the program?

Level 2 Learning Evaluation

Overall purpose: To evaluate what learning (knowledge, skills and attitudes) participants have developed as a result of NPD Gateway

Dimension Assessed	Purpose for the Evaluation of NPD Gateway	NPD Gateway Evaluation Questions
NPD process	To assess the development of knowledge, skills and attitudes in relation to the critical success factors for NPD.	• As a result of the program have you increased your understanding of what is required to successfully bring a new product to market? • As a result of the program have you development your skills (capabilities) to successfully bring a new product to market? • As a result of the program have your attitudes towards new product development changes? • Please indicate what learning statement (defined below) best describes your knowledge, skills and attitudes: - prior to entering into the program - currently and as a result of entering the program - desired for the future of your business - not relevant to your business • Please add any further comments that briefly describe how your knowledge skills and attitudes have changed as a result of the program.
Project Management		
Resource Management		
Portfolio Management		
NPD Strategy		

Learning Statements for each Dimension Assessed

	NPD Process	Project Management	Resource Management	Portfolio Management	NPD Strategy
Knowledge	We understand the importance of a *structure approach* to NPD and the activities involved in bringing a new product to market	We understand the role of *project management* in NPD and the tools and capabilities that are required to effectively manage a new product idea from conception to launch	We understand the nature of *resource management* for NPD and the tools and capabilities required to ensure we utilize appropriate resources at the right time	We understand the importance of portfolio management for sustained NPD success and the tools and capabilities required to successfully introduce a portfolio of new products to market	We understand the importance of developing a NPD strategy for our business in order to ensure sustained success and the tools and capabilities required to achieve this
Skills	We have developed skills / business capabilities to implement a structured process approach to NPD within our business	We have developed skills / business capability to effectively manage a NPD project	We have developed skills / business capabilities to effective manage resources during a NPD project	We have developed skills / business capabilities to effectively manage a portfolio (group) of NPD projects from conception to launch	We have developed skills / capabilities to develop a NPD strategy for our business
Attitude	We are willing / intend to develop and implement a structure process approach to NPD within our business	We are willing / intend to develop and implement project management within our business	We are willing / intend to develop and implement resource management within our business	We are willing /intend to develop and implement portfolio management within our business	We are willing / intend to develop and implement a NPD strategy for our business

Level 3 Behavior Evaluation *Overall Purpose*: To evaluate whether the knowledge, skills and attitudes participants have developed as a result of NPD Gateway has be transferred to organisational practice i.e. influenced a change in behavior.	**NPD Gateway Evaluation Question** Are you doing anything differently within your business as a result of entering into the program? If yes, could you please briefly describe what you are doing?
Level 4 Results Evaluation *Overall Purpose*: To determine what tangible results had been achieved as a result of participation in NPD Gateway.	Data will be gathered from MAS-WM performance measures and publically available information

3. Level 3 – Behaviour Evaluation

   The overall purpose of Level 3 – behaviour evaluation was to evaluate whether the knowledge, skills and attitudes that participants had developed, as a result of NPD Gateway had influenced a change in behaviour. Behaviour evaluations assess the transfer of learning as a result of the training program (Kirkpatrick 1998).

   The behaviour evaluation of NPD Gateway provided an assessment of the extent to which the learning facilitated by the process had been transferred to organisational practice. That is, whether the NPD success factors targeted had been implemented within the participant's organisations (SMEs). This provided an indicative measure of the perceived value of the learning facilitated. It was considered that if participants did not perceive any value in what they had learned, then they were unlikely to do anything differently within their organisation.

4. Level 4 – Evaluating Results

   The overall purpose of Level 4 – results evaluation was to determine what tangible results had been achieved as a result of participation in NPD Gateway. Evaluating at this level was important as it enabled the highest level of rigor by providing a measure of success in organisational terms.

   The results evaluation of NPD Gateway determined the value of the process and the learning facilitated in terms of organisational results. Value was defined as a measure of the "impact and positive change" (Abernathy 1999) within the organisation as a result of NPD Gateway. Impact was defined in terms of quantitative organisational measures including: new product introductions, sales generated and number of jobs created. A positive change was defined in terms of business development activities and the implementation of improvements, which would support sustained NPD success.

   The evaluation sought to gather data that provided 'evidence' as oppose to 'proof' of results, as typically gathering proof is likely to be unattainable and impractical (Kirkpatrick 1998). This is because there are a number of causal factors that affect results, making it difficult to attribute cause and effect. The evidence gathered

considered both hard and soft issues and provided both quantitative and qualitative measures.

Data Collection and Analysis

A self-completing questionnaire was developed to administer the evaluation for: Level 1 - reaction, Level 2 - learning and Level 3 - behaviour. This method demanded the minimum amount of time from participants and provided an appropriate method for considering the multiple elements of NPD Gateway.

The questionnaire consisted of open-ended and closed-ended questions. This enabled an assessment of the pre-defined elements of the NPD Gateway process and also captured richer data of participant responses in their own words. Additionally, the questionnaire incorporated a five-point likert scale that enabled the intensity of participant's views to be measured (Weisberg, Krosnick et al. 1996). A five-point scale also allowed for a middle alternative/neutral response to each question, which recognised and captured all possible opinions. The first and last points of the scale were labelled with words to ensure the clarity of the meaning of the points within the scale.

A draft questionnaire was reviewed, tested and revised by members of MAS-WM and WMG. The final version of the questionnaire was issued online on the 18th November 2011. The questionnaire was targeted to the business owners (project leads) of the participant SMEs. The evaluation sample included all participants (past and present) whose contact details were recorded on the MAS-WM database at the time of the evaluation. In total 44 SMEs were approached during the evaluation. Participants were asked to complete the questionnaire within a two week period, after which follow-up emails were sent out to all non-respondents in order to achieve the best possible response rate. (A 45% response rate was finally achieved)

Level 4 - Results evaluation was administered in the form desk research that considered performance measurement data and independent published articles regarding participant SMEs, which had been collected by MAS-WM.

7.1.3 The Results and Analysis

Figure 7-2 Evaluation Sample, illustrates the evaluation sample in term of the stages of the NPD Gateway process each participant was currently in.

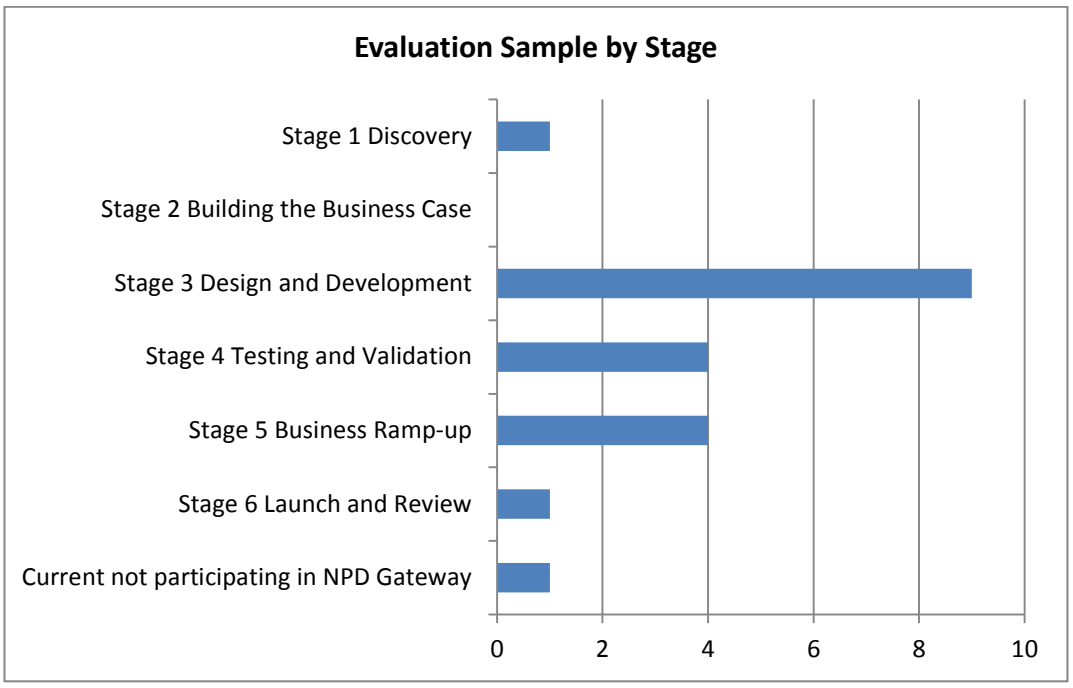


Figure 7-2 Evaluation Sample

Reaction

Overall, NPD Gateway had made a positive impact on participants. The respondents have indicated that the NPD Gateway process was "very appropriate" for supporting NPD within SMEs. Furthermore, the results confirmed that the four objectives of the process were being achieved:

- 80% of respondent's indicated that the program had increased the rate of the successful commercialisation of their new product idea.
- 75% of respondents indicated that the support and mentoring they had received during the program was 'very appropriate'. However, a small number of respondents (15%) highlighted a skill gap within the programme in areas including: business start-up, production and sales.

- 80% of respondents indicated that the programme had promoted an understanding of NPD as a complete business process.
- 60% of respondents indicated that the programme had encouraged and supported the embedding of elements of the NPD Gateway process within their businesses. However, a significant number of respondents (30%) indicated that the embedding of the NPD Gateway process was not applicable for the business.

The participants have responded favourable to all aspects of the program, particularly the delivery methods and the capabilities of the facilitators. These elements were important for establishing the learning objectives of NPD Gateway, which was advocated by the implementation of Logical Learning. Within the process the role of the MAS advisor was defined as one of a mentor to participants during the process. They were responsible for facilitating collaborative learning and development through a 'learning-by-doing' approach. Therefore, participant learning was dependent in part on the knowledge and capabilities of the MAS advisor. The results of participant reactions suggested that this element was being received well. Specifically, the meetings that participants held with the MAS advisors have been identified as "very effective" by 80% of respondents, as illustrated in Figure 7-3 Efficiency of delivery methods. Furthermore, a large majority of respondents (75% and 95%) indicated that the quality of the knowledge of the MAS Advisors and NPD Gateway Panel were "very high" respectively.

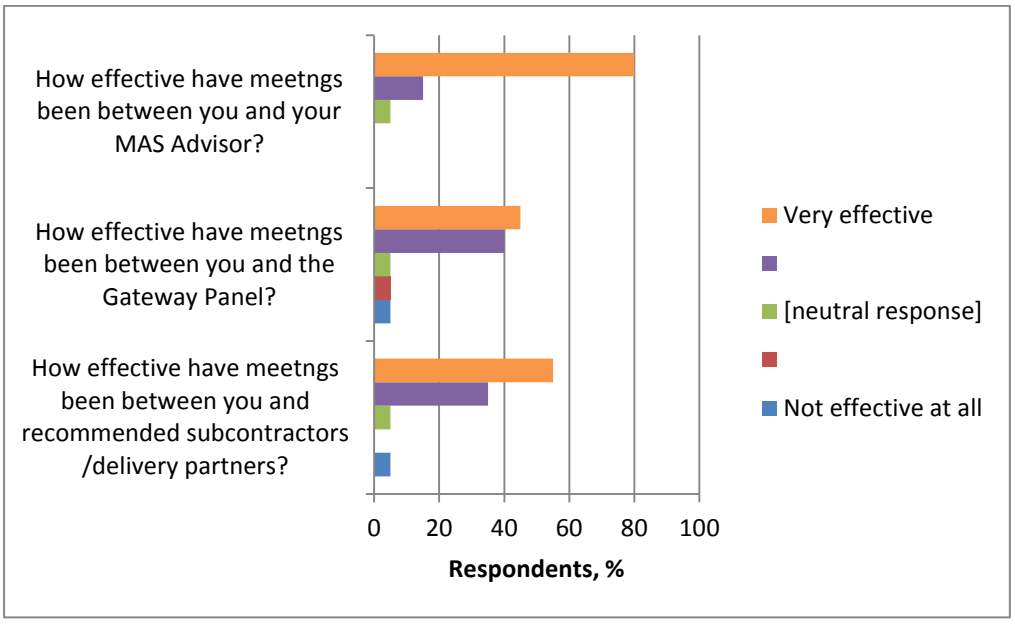


Figure 7-3 Efficiency of delivery methods

Additionally, the use of process documentation was identified as an area for further improvement. The NPD Gateway Process Manual and the Gate Paper and Diagnostic were the two main documents used within the process. Whilst a large majority of respondents were aware of the process manual (85%) and receiving value from it, fewer respondents had used the Gate Paper and Diagnostics (65%). This result was significant as the Gate Paper and Diagnostic was the main document that governed the process. It had been used for communicating participant requirements, assessing individual projects and capturing decisions and actions as projects progress through the process. 50% of those who had used this document indicated that it was a useful document. Therefore, it was determined that further consideration of the use of the document was required to ensure the maximum value was gained from it. Additionally, a small number of respondents suggested further improvements including: additional support in developing business skills and the timeliness of the process.

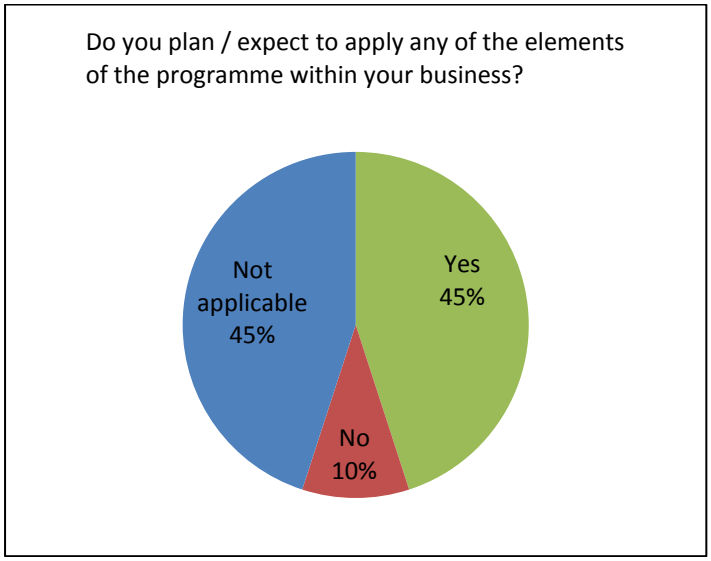


Figure 7-4 Planned action/transfer expectations

The respondent's reactions suggested that there were diverse motivations amongst the participants to apply the elements of the NPD Gateway process within their businesses. 10% of respondents indicated that they had no plans to apply any elements of the process within their businesses and a further 45% indicated that transfer plans were "not applicable" to them. However, 45% of respondents indicated they had plans to

apply the elements of NPD Gateway within their businesses. These results suggested that the NPD Gateway process had impacted on the organisational practices of some SME participants. This factor was investigated further during the evaluation of changes in behaviour, and is discussed below.

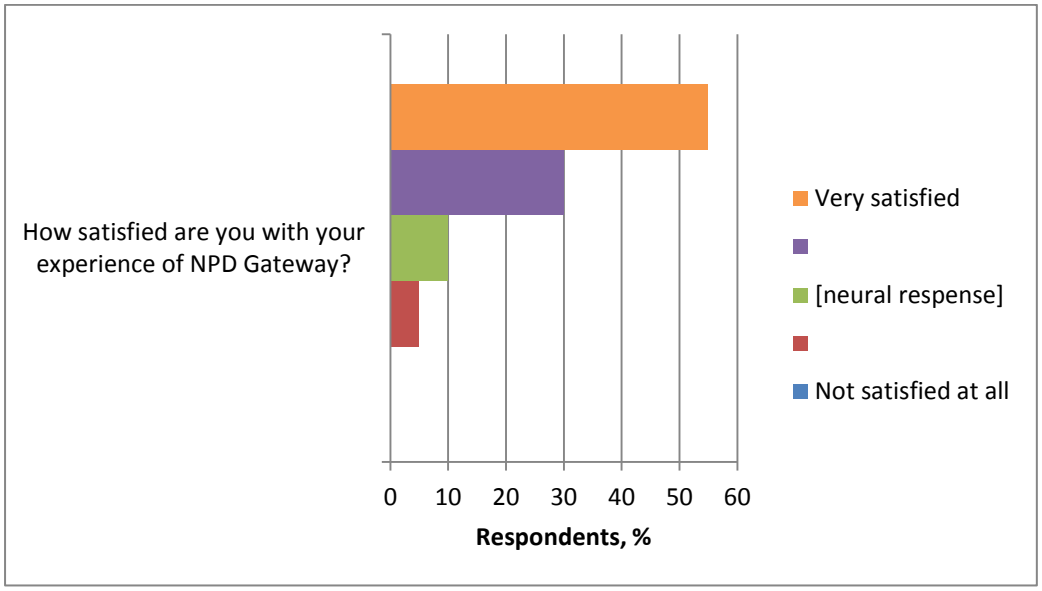


Figure 7-5 Overall reaction

Figure 7-5 Overall reaction shows that the overall impact of the NPD Gateway process has had on participants was high. This is evidenced with over 50% of respondents indicating that they were "very satisfied" with their experience of the process (a further 30% indicated that they were "satisfied"). People learn better when they accept training willingly and react positively to the form it takes (Carnevale and Schultz 1990). Therefore, the overall results demonstrated that the potential impact of the process on participant learning and subsequently organisation practice was promising.

Learning

Figure 7-6Participant learning as a result of NPD Gateway shows that the NPD Gateway process has had an impact on learning. 80% of respondents indicated improvements in their knowledge of the requirements of successful NPD. 65% indicated improvements in skills/capabilities. Moreover, 75% indicated that their attitudes towards NPD had

changed as a result of their involvement in the process. Figure 7-2 Evaluation Sample, shows that the respondents were currently at various stages within the process. Therefore, the results provided evidence that the 'learning-by-doing' approach was effectively being implementation during various stages of the process.

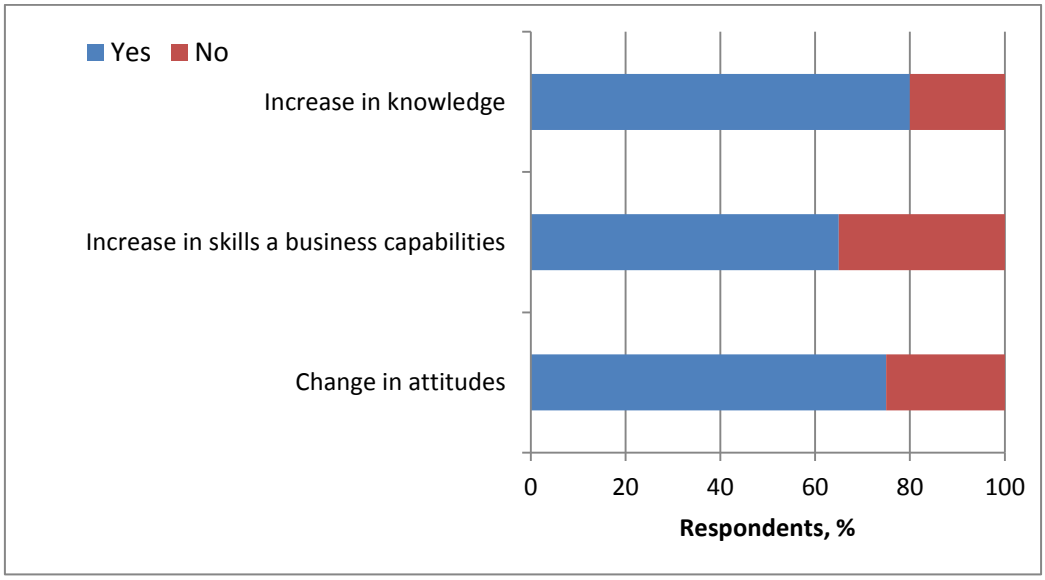


Figure 7-6Participant learning as a result of NPD Gateway

Some respondents indicated that they had existing: knowledge, skills and attitudes regarding the NPD success factors targeted. The majority of respondents identified prior understanding of the importance and requirements of project management and a willingness/intention to develop and implement a NPD strategy for their businesses. However, prior skills/capabilities to implement the NPD success factors were relatively low in comparison to prior knowledge. This was particularly true of the ability to develop and implement a structured process approach for NPD.

Figure 7-7- Figure 7-9 shows that as a result of NPD Gateway participants had developed the following:

- An understanding of the NPD success factors targeted
- The capability to develop and implement the factors within their organisation
- A willingness/intention to implement the success factors targeted.

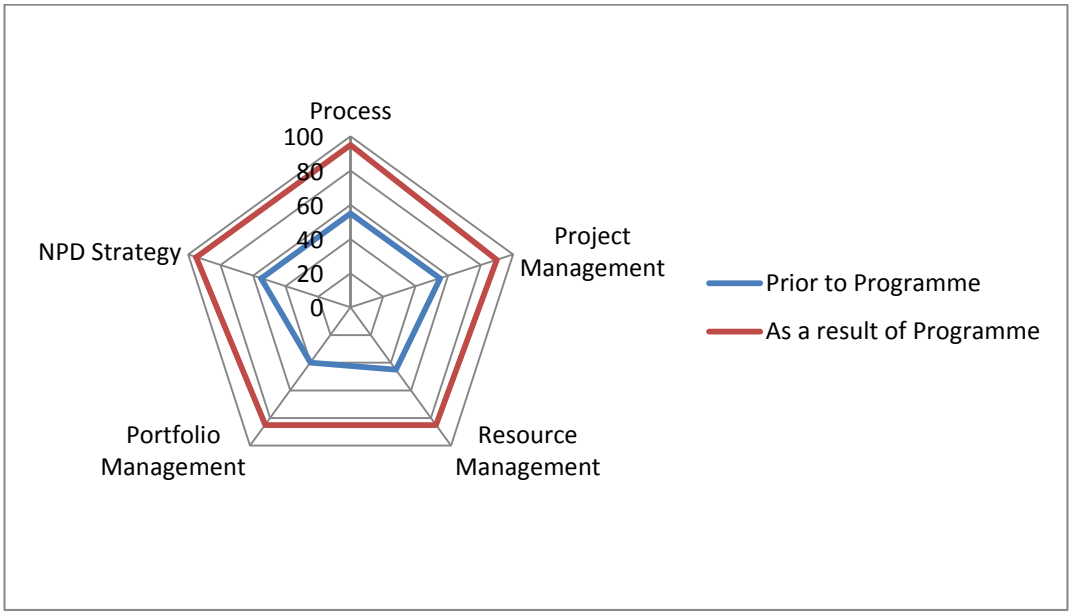


Figure 7-7 Development of knowledge

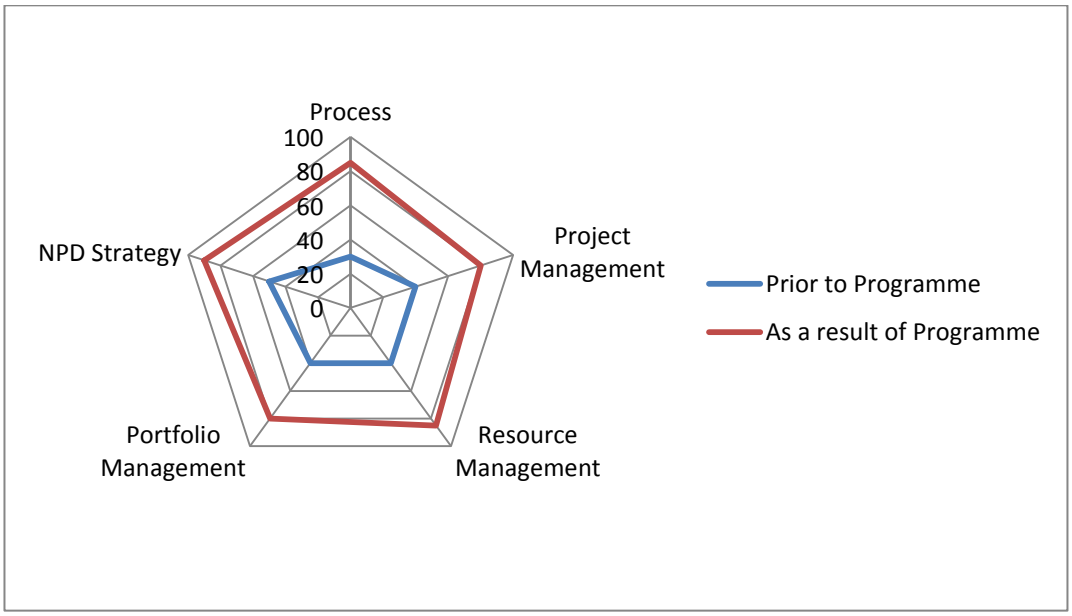


Figure 7-8 Development of skills/capabilities

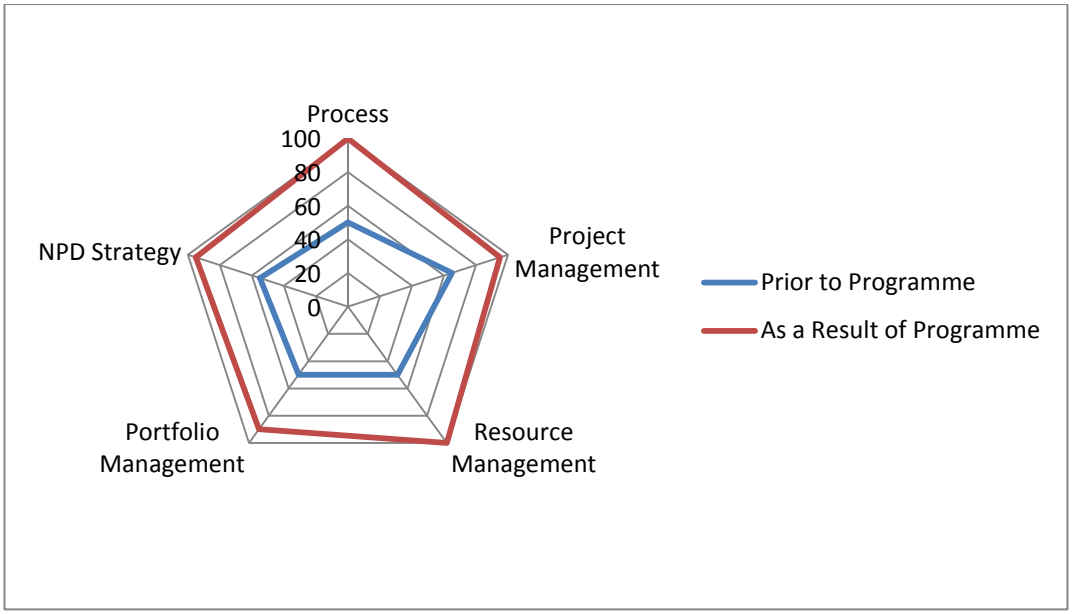


Figure 7-9 Development of attitudes

Therefore, evidence has been generated that links participation in the NPD Gateway process to participant learning regarding the five areas targeted. Namely: NPD process, project management, resource management portfolio management and NPD strategy. An indication of the impact of this learning on organisational practice was also captured by the respondent's additional comments on learning. These comments have included the identification of behavioural changes within participant organisations, including the implementation of more "formalised" and "structured" processes. Changes in behaviour are considered in more detail in the following section.

Behaviour

The results show that participant learning has influenced a change in behaviour, as indicated by 45% of respondents (Figure 7-10 Changes within business as a result of NPD Gateway). Particularly, the learning facilitated by NPD Gateway had supported the implementation of more organised approaches to NPD and improvements to resource management. NPD Gateway had also facilitated the definition of a strategy for NPD within one participant organisation, with one respondent indicating an intention to now *"launch a new product every 12 months"*. Overall, the changes in behaviour that were identified were reflective of the implementation of NPD success factors relating to the effective management and organisation of NPD. They involved three areas targeted by

the Logical Learning model: NPD process, project management and resource management.

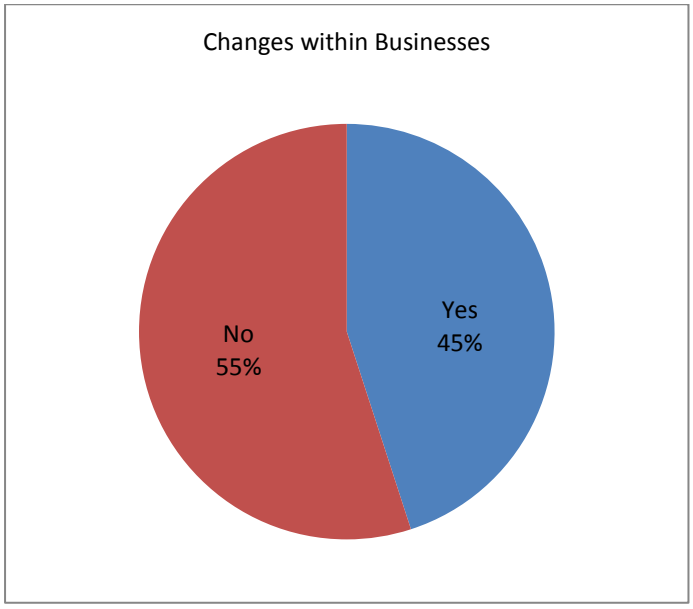


Figure 7-10 Changes within business as a result of NPD Gateway

The percentage of respondents that indicated that no changes had been made within their business as a result of NPD Gateway (55%) were comparable to that of those who had no plans/intention of applying any of the elements of NPD Gateway within their businesses (refer to Figure 7-4 Planned action/transfer expectations). Therefore, it was concluded that the respondents that intended to make changes to their organisational practice had achieved learning as a result of the process, which had enabled them to make the necessary changes.

However, this result also suggested an opportunity to better encourage the transfer of participant learning to organisational practice. That is, to ensure more participants were better equipped to achieve sustained NPD success following participation in the NPD Gateway process. This involved encouraging more participants to adopt good NPD practices following their participation in the process. Furthermore, it involved encouraging the implementation of the further factors targeted by Logical Learning e.g. portfolio management and NPD strategy.

A change in behaviour requires: a desire to change, appropriate knowledge and skills, and the 'right' climate (Brewer, Peters et al. 2007). Evidence of a change can only be gathered once the learner has had time to consider and apply suggested behaviour, and this can take place at any time following the learning event (Kirkpatrick 1998). The evaluation of participant learning provided evidence that respondents had developed appropriate knowledge, skills and attitudes to implement targeted organisational practices. Therefore, the achievements of actual changes to organisational practices were dependent on the organisational 'climate'. Hence, it was assumed that some participants may not have had the opportunity to implement changes within their businesses. This conclusion was further supported by the fact that at the time of the evaluation the majority of respondents were still participating in the NPD Gateway process (as shown in Figure 7-2 Evaluation Sample). As a result, they may not have had the time or space to focus on organisational improvements. The researcher recognises that further assessment is required to test the validity of this conclusion.

However, evidence had been gathered and determined that learning had been transferred to practice, as indicated by 45% of respondents and their supporting comments. The evaluation of changes in behaviour had built on the chain of impact that linked the NPD Gateway process to participant learning and furthermore, linked the process to changes to NPD practices within participant's organisations.

Organisational Results

Table 7-2 Organisational results, shows that the NPD Gateway process had made a significant impact on participant SMEs in terms of quantitative organisational measures. Furthermore, participants have reported developments within their businesses that will support sustained NPD success.

The NPD Gateway process had so far resulted in 8 new product introductions, which according to MAS-WM figures had generated sales of between £50,000 and £14 million for individual SMEs for the period 2011-2012. All participants that had launched a new product were also forecasting increases in sales of between 13% and 2100% in their second year (i.e. 2012-2013). As well as identifying the commercial impact of the NPD

Gateway process for SMEs, the results demonstrated an impact on the UK economy in the form of job creation. Collectively, the companies that had launched new products had generated 93 jobs within the West Midlands region, which contributes to economic development within the UK.

The evaluation of results also provided qualitative measures of NPD achievements and identified business development activities that participant organisations were engaged in, which will support their sustained NPD success:

- Spacana and Grill Stream Technology had secured international agreements to distribute and licence their new products respectively. This demonstrated an increasing reach of their businesses and the success of their new products.
- Tails and Cobra UK had secured contracts with leading organisations and reported plans in launch further new products. This demonstrated a commitment to continuous and consistent NPD within their organisations
- Cobra UK was also a winner of the Queens Award for Enterprise in 2011
- Metrasens and Gekko Technology had secured private investments for business development and growth.

Table 7-2 Organisational results

Company Name	Product Details	Product Launch		Sales Generated, £			Jobs Created	Additional Achievements
		Y/N	Date/ Expected	Actual (2011-2012)	Forecast (2012-2013)	% Increase		
Metrasens	Ferrous metal detector for MRI scanners	Y	2010	1.2 mil	3.2 mil	167%	25	Established overseas territories (USA and India Due to record first profits in 2011 Secured private equity funds twice
Tails Ltd	Tails Cocktails - authentic bar-quality cocktails range	Y	2011	50,000	1.1mil	2100%	4	New business and brand created Plans to launch a second new product is underway in partnership with a leading British organisation
Cobra, UK	Low-mass load floor	Y	2012	14 mil	16.9mil	21%	40	Won Queens award for enterprise in 2011. Secured annual contract with General Motors worth 2.9 mil Plans to launch a second new product are underway
Grill Stream Technology	Technology for 'smoke-free' bar grilling and cooking	Y	2011	50,000	250,000	400%	3	New business created Secured 3 international licensing agreements including the 4th largest barbeque manufacturer Established manufacturing facilities for aftermarket products in the UK. Working with major pub restaurant chain to engineer grill stream

								technology into cookers
Spacana	The ORB professional	Y	2011	50,000	1mil	1900%	4	Secured international distribution agreements across Europe (Italy, France, Germany) and two in USA
Gekko	Kedo™ - single source light source for film, television, photographic and entertainment industries	Y	2011	1.5 mil	2.25 mil	50%	10	Secured investor to support business development and growth
Coach Built	Adaptations of caravans & motorhomes for the disabled	Y	2010	750,000	850,000	13%	5	Market leader within two years of business start up
Strand Hardware	Window hardware (openers and closers)	Y	2012	2.02 mil	2.37mil	17%	2	New product range with increased gross profit margin & safeguarding 14 jobs

Source: MAS-WM (March 2012)

7.2 Summary of the Validation of Logical Learning

To ensure the improved quality of the evidence generated and to strengthen the validity of research outcomes, a summative evaluation model was used to validate the significance of the application of the Logical Learning model within NPD Gateway. The Four Levels Model was used to develop a comprehensive and rigorous framework for the evaluation of learning as a result of the application of the Logical Learning model.

The evaluation of the learning of SMEs who had participated in NPD Gateway validated the significance of the Logical Learning. The results have provided evidence that links participation in NPD Gateway to learning within SMEs. This learning has been linked to changes in behaviour and NPD practices. Furthermore, changes in behaviour have been linked to organisational results.

Participants have reacted favourable to all the elements of NPD Gateway and indicated that the objectives of the process were being met. Over 50 % of respondents were “very satisfied” with their experience and a further 30% were “satisfied”. Two elements that were important for establishing the learning objectives of the process include: the process delivery methods and the capabilities of the mentors and facilitators. Participants have found both of these elements particularly useful.

NPD Gateway has impacted on learning within participant SMEs at all stages of the process. 80% of respondents have indicated improvements to their knowledge of the requirements of successful NPD. 60% indicated improvements in skills and capabilities and 75% indicated that their attitudes towards NPD had changes as a result of participation in the process. Further evidence has been generated and demonstrated learning involving all five areas of NPD which were targeted by the Logical Learning model. That is, successful NPD practices relating to: NPD process, project management, resource management, portfolio management and NPD strategy for sustained success. Participant understanding of the requirements of these areas have been developed, so too has their ability to implement appropriate practices within their organisations. Furthermore, as a result of the process more participants are now willing/intend to implement the practices for successful NPD within their businesses.

This learning has been transferred and has led to changes to organisational practices within participant SMEs. The evaluation of changes in behaviour provided evidence that overall, the learning facilitated by NPD Gateway had supported the implementation of more organised approaches to NPD, better project management and improvements to resource management. There is an opportunity to further facilitate changes to organisational practices relating to other areas targeted by Logical Learning including: portfolio management and a NPD strategy.

Finally, the evaluation of organisational results established the commercial value of the NPD Gateway process. The process has resulted in 8 new product introductions to market. According to MAS-WM figures these products have generated actual sales of between £50,000 and £14 million within individual SMEs. Collectively the SMEs that have launched new products have generated 93 additional jobs within the West Midlands, UK. This demonstrates a further contribution to economic development within the UK. Moreover, these SMEs report further business development achievements, including the establishment of: partnership with market-leading organisations, international distribution agreements and further private investment to support business growth.

The evaluation of participant learning has proven the applicability and value of NPD Gateway in facilitating participant learning. In doing so the evaluation has validated the application of the Logical Learning model within the process. This learning element of the process is at the heart of the successful improvement of participant's knowledge, attitudes and capabilities, which have ensured they are better equipped to continuously and consistently succeed at NPD.

8 Final Reflection and Recommendations for Future Work

The purpose of two cycles of action research has been to answer the research question through action and reflection and ultimately demonstrate innovation in the application of knowledge within an engineering business. A final reflection on the research discusses the extents to which the purpose and objectives of this research have been achieved and identifies opportunities for further work, which allows for greater scope for innovation.

8.1 Achievement of Research Objectives

The initial research question considered how Small-Medium sized Enterprises (SMEs) practically implement existing knowledge of NPD success factors by asking:

How is existing knowledge of the requirements of successful NPD translated into practice within SMEs?

To this end three research objectives were defined:

RO1. To develop an understanding of organisational challenges in implementing NPD success factors and sustaining good practice, within an SME context.
RO2. To develop a mechanism that overcomes these challenges and translates existing knowledge of success factors into appropriate organisational practices.
RO3. To demonstrate validity and value in the application of the mechanism within an SME context.

8.1.1 Understanding Organisational Challenges within SMEs

Practical insights into the organisational challenges SMEs face in implementing NPD success factors have been gained through an exploratory study during the first cycle of action research (ARC1). The study involved an intervention within an SME context in

the form of a NPD improvement project within Magal Engineering Limited (Magal). Magal were a UK-based group of eight SMEs however, the research focused on a core SME with the group, namely Automotive Product Driveline Technologies (APDT). Research efforts have identified factors relating to: people, process, politics and technology within the SME, which have made implementation efforts challenging. Section 4.2 of this report identified the following challenges identified within Magal:

- *People challenge* - the collective challenge of developing knowledge and capabilities. This includes ensuring the knowledge of both the requirements of NPD success and once improvements are implemented, ensuring understanding of planned changes that are introduced. Furthermore, the 'people challenge' included the challenge of developing capabilities within the SME to implement NPD success factors.
- *Process challenge* - the challenge of developing appropriate approaches by way of tailoring existing knowledge of 'best practice' to suit the specific organisational context i.e. the SME environment.
- *Political challenge* - the challenge of ensuring power and influence in order to facilitate improvements and change within the SME. This includes achieving commitment and ownership of NPD improvements and ensuring NPD process governance.
- *Technology challenge* - the challenge of justifying and achieving investment in appropriate technology that will not only support the management of NPD but also potentially improve the nature of the new product offering produced.

These challenges were established as inter-dependent and interacted to influence the achievements of the NPD improvement project within Magal. They centred on a need to develop: understanding, capabilities and commitment within the SME, which would support the implementation of NPD success factors and the continuous improvement of NPD practices in order to ensure sustain success. This knowledge is contextual as understanding of the challenges has been developed through reflection of data gathered within Magal from: semi-structured interviews, observations during the project and the evaluation of the achievements within the SME. Therefore further research is required to investigate the extent to which the organisational challenges are true of all SMEs.

However, the exploratory study increased understanding of NPD within an SME that led to the refinement of the research question. Despite the organisational challenges faced, an internal evaluation within Magal demonstrated that the NPD improvement project had a positive impact on the SME and their way of working. It had successfully implemented NPD success factors including a structured process approach and effective project management. Recognising that sustained NPD required the implementation of the more strategic success factors i.e. portfolio management and NPD strategy, a need for further improvement was identified. Subsequent research efforts therefore focused on establishing what actions had led to the successful implementation of good NPD practice amid: people, process, political and technology challenges. Furthermore, research efforts considered how these actions could be improved to influence further improvements.

On reflection it became apparent that it was the action research approach employed that had begun to overcome the challenges, it had enabled learning and the practical implementation of NPD success factors within Magal. It would be this continuous learning that would develop further capabilities that would take the SME further on its NPD improvement journey.

Hence, learning was hypothesised as an appropriate concept to support the implementation of NPD success factors and sustained NPD success, where learning was defined as: *"the human process by which skills, knowledge, habit and attitudes are acquired and altered in such a way that behaviour is modified*" (Beach 1980, as cited by Robert 2000). This hypothesis was initially tested with consideration to the literature, where a relationship between organisational learning, organisational capability and organisational practice was identified (Chaston Badger et al. 1999). Knowledge of this relationship strengthened the feasibility of learning as a mechanism for developing the understanding, capabilities and commitment necessary to overcome the challenges and successfully influence organisational practice. Therefore the research question was refined as follows:

How is organisational learning (i.e. the development of knowledge, skills and attitudes) facilitated within SME to support the implementation of NPD success factors and sustained success?

This stage of the research contributes to the NPD body of knowledge by providing an understanding of the practical challenges an SME faces in adopting NPD success factors and sustaining success. Such knowledge is increasingly relevant today as organisations operate in an environment of constant change. Recent literature argues that research is therefore required to provide knowledge that helps organisations change and adapt to perform effectively (Mohrman and Edward E Lawler 2012). Mohrman and Edward E Lawler (2012) argue that such knowledge should be generated by connecting with practitioners to understand complex problems and contribute to solutions. The research findings during the exploratory study have been generated in such a manner - in collaboration with an SME - and can inform future research concerning organisational change and the effective implementation of good practice NPD.

The first objective of this research has been met. The exploratory study and NPD improvement project have developed an understanding of the organisational challenges in implementing NPD success factors within an SME context. Moreover, the scope of the achievements i.e. the development and implementation of the comprehensive Magal Business Management System (MBMS) potentially has applications for further research concerning engineering business management.

8.1.2 Developing a Mechanism to Overcome Challenges and Influence NPD practice within SMEs

In re-framing the research question to consider learning the second objective focused on developing a learning model to overcome organisational challenges and effectively influence NPD practices within SMEs.

Four existing approaches to learning were reviewed and enabled an understanding of different perspectives on learning. The review identified a need for a new accessible approach to support learning within SMEs for the purpose of the present research. It was established that a new approach should effectively capture existing knowledge of

all NPD success factors, appropriately direct learning efforts and ensure a balance between: knowledge, skills and attitudes in order to effectively influence organisational practice.

To this end, Section 5.3 of this report established a new model, namely Logical Learning that facilitates organisational learning within SMEs, to support the implementation of NPD success factors and ensure sustained NPD success. Existing concepts within the literature were interpreted and combined to form the new conceptual model. These concepts included: The Three Modes of Learning (Pedler, Burgoyne et al. 1997), The Focus, Will, Capability Performance System (Smith and Tosey 1999) and Maturity-based tools e.g. CMMI (CMMI 2010). The Logical Learning model exploits an original relationship between existing NPD success factors that supports their implementation and the sustained success of SMEs. It consists of five incremental components that capture existing knowledge of critical NPD success factors, including: NPD process, project management, resource management, portfolio management and NPD strategy. It is original in its focus on NPD within SMEs and its identification of a bottom-up relationship between its components, which is contrary to the traditional hierarchy for strategy implementation. This relationship defines incremental stages of an SME's journey of learning and implementing improvements to NPD practice. The journey begins with the implementation of a NPD process and ends with the implementation of a NPD strategy for sustained success. This journey is enabled by a learning-by-doing approach i.e. Action Learning.

Logical Learning was in-part based on the actions taken during the NPD improvement project within Magal, which had successfully overcome the organisational challenges and influenced NPD practice. The model effectively identified further stages in the SMEs improvement journey and an approach for successful intervention within the business amid people, process, political and technology challenges.

This stage of research contributes to the NPD body of knowledge in the form of a new conceptual learning model, which is applicable to supporting NPD within SMEs. This model provides knowledge of how learning can be facilitated within SMEs to support NPD. It is relevant to recent research that is emerging concerning the nature and

purpose of learning and capability development within SMEs (Higgins and Aspinall 2011). Furthermore, it contributes a new perspective on NPD within SMEs by proposing a bottom-up relationship that effectively moves SMEs from the implementation of a NPD process to a NPD strategy for sustained success. This progression is contrary to traditional thinking and creates a potentially better option to support NPD strategy development and implementation within SMEs in the future.

The second objective has been met. Logical Learning provides a mechanism that overcomes organisational challenges and supports the practical implementation of NPD success factors within SMEs.

8.1.3 Demonstrating Validity and Value in the Application of the Mechanism

The Logical Learning model was applied and validated during the second cycle of action research (ARC2), through the development of the New Product Development Gateway process (NPD Gateway) within the Manufacturing Advisory Service in the West Midlands, UK (MAS-WM).

ARC2 took place in a different SME context to ARC1, however the two action research cycles were linked such that the learning developed in the reflection phase of ARC1 i.e. Magal, was transferred to planning phase of the ARC2 i.e. MAS-WM. The purpose was to strengthen new knowledge that had been developed (i.e. Logical Learning) and generate evidence to validate its contribution to NPD practices within SMEs.

MAS-WM provided an appropriate context within which the research could investigate the potential application of the model and access its validity for SMEs. While preceding research efforts focused on a single SME, MAS-WM focused on supporting NPD within a range of SMEs and hence provided greater scope for establishing the significantly of the research contributions.

Chapter 6 Application of the Logical Learning Model describes how the Logical Learning model has been implemented within NPD Gateway and now underpins value of the process. Fundamentally, NPD Gateway was viewed as a process that could not only

support the commercialisation of new product ideas of SMEs in the West Midlands, UK (as it was originally conceived to do). It also provided a mechanism for facilitating 'learning-by-doing' through participation in the process. The elements of the model were adapted and provided a framework that directed learning. That is, the development of knowledge, skills and attitudes, to support the implementation of critical NPD success factors. This ensured participant SMEs were better equipped to sustain NPD success. The model now defines the underlying strategy of the NPD Gateway process. The Innovation Team Leader for MAS-WM, Roy Pulley, commented on the nature and significance of this core learning element of the process:

"the 'learning-by-doing' for participating companies has transferred knowledge helping to embed the critical NPD success factors into their organisations….The MAS-WM Gateway Process supports clients in making innovation the strategic imperative for their business. By collaboratively developing in-company capabilities to develop a NPD process, manage projects and resources, the companies are closer to successfully executing a portfolio of NPD projects. These product commercialisations will continue to raise their global competitiveness and contribute to the UK economy"

The NPD Gateway process itself contributes to knowledge of appropriate business intervention programmes to support NPD within SMEs. In October 2011 it became part of a new nationwide government funded programme (the Manufacturing Advisory Consortium) aimed at helping SMEs unlock their growth potential through areas including New Product Development and Introduction.

NPD Gateway was developed with consideration to the characteristics and constraints of SMEs to ensure the process included elements that support SMEs in these areas. Small businesses are typically constrained by resources in terms of finance and access to expert skills to support innovation. Therefore the process was developed to provide four key elements of business support:

- A structured new product development (NPD) process and methodology to mitigate technical and commercial risk throughout the development activities up to commercialisation

- 'One-to-one' mentoring by experienced product innovation advisors and sign-posting to technical and commercial expertise and resources
- Matched funding to mitigate the cost of all relevant externally provided resources
- An 'over-arching' monitoring and control of the product development activities from a widely experienced NPD Gateway Panel

NPD Gateway was launched on 1st April 2010 and was applied to SMEs in the West Midlands, UK. Informal feedback from participants identified the value of the process for supporting the commercialisation of NPD product ideas and learning within SMEs. However, in order to rigorously test the significance of the Logical Learning model within the process a formal evaluation of the learning facilitated was conducted.

The evaluation developed improved methods of data collection from those used to evaluate the outcomes of ARC1. The evaluation of the NPD improvement project at Magal was not an evaluation of learning in that it did not assess knowledge, skills and attitudes. Furthermore, the assessment of the impact of the research efforts on the SMEs was limited in that the evaluation did not consider organisational measures. Therefore, to ensure improved quality of the evidence gathered and to strengthen validity of research outcomes, in validating Logical Learning the Four Levels model for learning evaluation (Kirkpatrick 1959; Kirkpatrick 1998) was used to develop a rigorous and comprehensive evaluation tool (as described in section 7.1 of this report).

The evaluation provided evidence that linked the NPD Gateway process to learning within SMEs and the adoption of NPD success factors, which ensured participants were better equipped to sustain success. Moreover, the evaluation demonstrated the significant commercial impact the process had on SMEs. Hence, the evaluation validated the application of the Logical Learning Model.

The validation of Logical Learning makes a further research contribution with the development of the evaluation framework (Table 7-1 Structure of the evaluation). The framework establishes the measurement tool that further supports the application of the Logical Learning model in guiding improvements to NPD practice within SMEs. This

tool is relevant to current research concerning how the organisational impact of learning is measured e.g. Bergh and Jacobsson (2011)

Measurement is a significant feature of existing approaches to learning e.g. the Focus, Will, Capability-Performance System and Audit Tools, which establish the current status of an organisation in order to guide improvements (refer to section 5.1 of this report). Measurement is essential for ensuring organisations are not only "doing things well" but are "doing things better" and therefore can be associated to the first and second stages of learning, as defined within the Three Modes of Learning Model (Pedler, Burgoyne et al. 1997). In order to sustain NPD success SMEs must continually re-assess their: knowledge, skills and attitudes and renew appropriate practices. Therefore the measurement framework for the evaluation of NPD Gateway should be used in conjunction with the Logical Learning model to assess the achievements of improvement objectives. Effectively in the context of an intervention within an SME the Logical Learning model should be used to guide and implement improvements while the evaluation framework assesses and monitors achievements.

The third and final research objective has been met. The development of the NPD Gateway process demonstrates the applicability of the Logical Learning model. Furthermore, the learning evaluation validates the contribution the model has made to participant SMEs.

8.2 Recommendations for Future Work

The completion of this project has presented opportunities for further work in the area of NPD within SMEs and more specifically learning and capabilities development within SMEs to support sustained NPD success. Recommendations for future work represent the potential next steps of this research.

8.2.1 Generalisation of Research Outcomes

The data gathered during the research is of a contextual nature as the outcomes have been grounded within the SMEs contexts that have been engaged with during the two action research cycles. Therefore, further empirical testing is required to establish the extent to which the research findings and outcomes can be generalised.

8.2.2 The Role of Logical Learning in the Context of an Intervention

Business interventions take place for many different reasons. This research has focused on interventions within SMEs to support the practical implementation of NPD success factors, to ensure these businesses are better equipped to sustain NPD success. Organisational learning has been identified as important in achieving this objective as it develops the necessary knowledge, skills and commitment to effectively influence organisational practice. The role of the Logical Learning model in such interventions is to provide incremental development stages in the implementation of NPD success factors, which guide improvements efforts. Furthermore, the measurement tool that accompanies the model is used to access learning and implementation achievements. This role has been validated in the application of Logical Learning within NPD Gateway. However the application of Logical Learning to support internal interventions within a single SME (such as the NPD improvement within Magal Engineering Limited) is yet to be established in practice. Therefore, there is an opportunity to further apply and validate the model in the context of an internal intervention within a single SME, to clarify the potential role it plays.

Additionally, during the current global economic downturn, increasing emphasis has been placed on not only supporting the NPD success of SMEs, but also supporting the growth of SMEs. Discussions with a critical expert have highlighted an analogy between the incremental stages defined within the Logical Learning model and the growth of an SME. It was recognised that it was only as SMEs grow and develop that factors relating to resource management and portfolio management become explicitly relevant. Although further empirical evidence is required to justify this observation, it suggests an opportunity for further research to investigate the use of the Logical Learning model as a growth strategy or plan for SMEs. This investigation could be extended to determine the time taken to progress through the stages of the model, which may

potentially identify further value of the model in accelerating understanding and the growth of SMEs, in order to support economic recovery.

8.2.3 Further Development of the Logical Learning Model

The Institute for Employment Studies (IES) identify five stages of a model for learning, which are used to provide an assessment of the Logical Learning model in order to identify areas for further development (cited by Tamkin, Yarnall et al. (2002)):

1. Stage 1: Identification of training need
2. Stage 2: The learning process
3. Stage 3: Learning outcomes
4. Stage 4: Behavioural change
5. Stage 5: Impact on others and organisation

The Logical Learning model recognises organisational challenges in translating existing knowledge of the requirements of successful NPD into appropriate practices within SMEs. The research has determined that in order to successfully influence organisational NPD practices, SMEs are required to develop their: knowledge of NPD success factors, their capabilities to develop and implement tailored solutions and furthermore, their commitment at all levels of the organisation in order to facilitate change.

An appropriate learning process to support NPD within SMEs has been identified in the definition of the components of the Logical Learning model. The process consists of incremental development stages and a 'learning-by-doing' mechanism.

There is an opportunity to further define the learning outcomes of the Logical Learning approach. In designing the framework used to evaluate the application of the model, learning statements were developed and provided descriptions of the: knowledge, skills and attitudes targeted by the application of the model. However, further research can take greater advantage of the extensive body of knowledge concerning NPD success factors, which can be used to provide extended descriptions of the learning targeted at each stage of the model. This will allow for a more rigorous self-assessment of learning

within SMEs and provide a more comprehensive insight of NPD success factors. Furthermore, extended descriptions will support the action learning coach in ensuring appropriate action and reflection to achieve the required learning objectives.

During the validation of the Logical Learning model (Chapter 7) limitations in the measurement of behavioural change i.e. a transfer in learning, were identified. Tamkin, Yarnall et al. (2002) established that a transfer of learning depends on a number of factors that are independent of the quality or appropriateness of the learning event itself. It was identified that this included organisational culture and climate (Brewer, Peters et al. 2007). These factors were not considered during the validation of Logical Learning. Therefore, there is an opportunity for further research to conduct an empirical investigation of how the model influences organisational culture and climate and the implications this has on behavioural changes.

The evaluation of the organisational outcomes as a result of the Logical Learning model was limited to the availability and accessibility of organisational measures, which were collected by MAS-WM. Similarly to the development of extended description of learning outcomes, there is an opportunity for further research to determine the expected organisational results of the learning targeted by the model. This knowledge could be used to improve the measurement of the impact of learning on the financial performance of SMEs.

8.3 Summary of Final Reflection and Recommendations for Future Work

The research has achieved its objectives. An understanding of the organisational challenges a SME faces in adopting NPD success factors and achieving sustained success has been developed. A mechanism to overcome these challenges has been developed in the form of the Logical Learning model. Furthermore, the validity and value of this mechanism has been demonstrated in the application of Logical Learning within the NPD Gateway process.

Recommendations for further work have been presented and include further empirical testing to: determine the extent to which the research findings can be generalised, to

further clarify the role of the Logical Learning model in the context of a business intervention and to further develop the model to enhance its use and impact on organisational practices and performance.

9 Conclusions

Innovation is of increasing importance to the sustained success of businesses and the economy. New products are a form of innovation and New Development (NPD) is the term used to describe the complete business process of commercialising a new product idea. There is an increasing emphasis on NPD within SMEs as the innovations they typically produce provide the highest potential contribution. However, SMEs are finding the implementation of NPD success factors challenging and there is a gap between existing knowledge of the requirements of success and their application in practice.

The research considers how existing knowledge of the requirements of successful NPD is translated into appropriate practices within SMEs. The research began within an SME, namely Magal Engineering Limited (Magal). Magal sought to implement improvements to their approach to NPD in order to ensure they sustain success. Hence, the objectives of the research was to understand the challenges the SME faced in implementing NPD success factors and develop an appropriate approach that overcame these challenges and influenced good NPD practice.

Through active involvement in a NPD improvement project within Magal, the research explored how NPD success factors are implemented within an SME. The researcher led the development and implementation of the comprehensive Magal Business Management System (MBMS), which included a NPD process and strategy for project management. During the development of the MBMS, the structure and content of the SMEs approach to NPD was improved. A three tier structure was established to promote an understanding of all core processes within the system. NPD was recognised as a core process and defined across structured activity charts. Personnel were engaged in the development of a comprehensive set of activity charts which ensured clarity of their roles and responsibilities and ownership of the process to support its sustained success. Furthermore, a Master Project Plan (MPP) was developed to improve the organisation and management of NPD within the SME.

The MBMS was launched on 1st July 2008 through a series of workshops, which were developed and delivered by the researcher. To determine the value of the improvement project and its outcomes, an internal evaluation was conducted. The evaluation demonstrated that a positive impact had been made on NPD practices within the SME. Specifically, the project had improved the clarity and understanding of approaches to NPD within the SME and the organisation and management of NPD projects. However, it was also identified that regarding sustained NPD success within the SME, the achievements were limited. Research efforts had not yet influenced the implementation of a NPD Strategy for the organisation. This finding informed the direction of subsequent research efforts.

Despite the limitations of the achievements within Magal, a reflection of the actions and outcomes of the project provided practical insights into the organisational challenges faced in implementing NPD success factors within an SME. Factors relating to: people, process, politics and technology have been identified as influencing interventions and improvements to NPD practices within an SME context. These factors were interdependent and centred on a need to develop: understanding, capabilities and commitment within an SME, to support the implementation of NPD success factors and furthermore, to enable continuous improvement to ensure sustained success. This understanding gained, highlighted organisational learning as important to achieving the research objectives, where learning was defined as: *"the human process by which skills, knowledge, habit and attitudes are acquired and altered in such a way that behaviour is modified*" (Beach 1980, as cited by Robert 2000). The researcher recognised that the actions taken during the improvement project at Magal had facilitated learning within the SME. Moreover, this learning had overcome the people, process, political and technology challenges within the SME and supported the successful implementation of NPD success factors. It would be this continuous learning that would take the organisation further on their NPD improvement journey towards sustained NPD success.

Therefore, as a result of the research findings, the research objective was refined to consider organisational learning as an appropriate mechanism to support the implementation of NPD success factors within an SME.

A review of the strengths and weaknesses of four existing approaches to learning followed and established the requirements of a new approach to support NPD within SMEs. The approach was required to; effectively capture existing knowledge of critical NPD success factors, appropriately direct learning and implementation efforts and ensure a balance between: knowledge, skills and attitudes, in order to influence organisational practice.

Drawing on achievements of the actions and outcomes of the NPD improvement project and existing concepts within the literature, the Logical Learning model was developed. Logical Learning facilitates the development of: knowledge, skills and attitudes within SMEs to support the implementation of NPD success factors and sustained NPD success. The model advocates a 'bottom-up' relationship between NPD success factors, akin to a logical progression of knowledge and capabilities within SMEs. Facilitated by action learning (Learning-by-doing), the model defined incremental development stages in a SMEs learning journey towards implementing critical NPD success factors, for sustained success. Logical Learning exploits an original 'bottom-up' relationship established through research, which effectively moves SMEs from the implementation of a project strategy (i.e. NPD Process) to the implementation of a NPD strategy for sustained success. This progression, although contrary to the traditional top-down 'strategy-portfolio-project' cascade, builds on the achievements of the NPD improvement project within Magal, which were reflective of the organisational challenges the SME faced. Logical Learning initially focuses on the potentially less political NPD success factors, but ensures the right structures are in place and the SME develops an understanding of its current capabilities, which will then aid essential strategic decision-making.

Having developed the Logical Learning model, subsequent research efforts sought to demonstrate how the model could be practically implement and furthermore, to validate its significance. This was achieved by engaging with the Manufacturing Advisory Service in the West Midlands, UK (MAS-WM). In collaboration with MAS-WM, the researcher has developed a unique innovation support programme in the West Midlands, UK, namely the New Product Development Gateway Process (NPD Gateway). The Logical Learning model has been implemented within this process and now underpins the strategy and value of the process. Research efforts have ensured that NPD

Gateway is a process that not only supports the commercialisation of new product ideas within SMEs (as it was originally conceived to do). It also facilitates learning through participation in the process, which supports the implementation of NPD success factors within participant SMEs. This ensures that participant SMEs are better equipped to sustain success. In this way the underlying strategy of the MAS-WM was enhanced. NPD Gateway is unique in the support it offers SMEs and the approach it employs, which is advocated by Logical Learning. The process was launched on 1st April 2010.

A comprehensive and rigorous learning evaluation framework was developed in order to assess the impact of model on NPD within SMEs. As a result, evidence has been provided that links the application of the model to learning within SMEs, learning to changes in behaviour and NPD practices and changes in behaviour to organisational results. Logical Learning has developed: knowledge, skills and attitudes within SMEs that have supported the implementation of good NPD practices and impacted on the commercial success of businesses. This has collectively ensured participant SMEs are better equipped to sustain NPD success. In October 2011 MAS-WM competed for and won a contract to delivery innovation support nation-wide. Hence, a national roll-out of NPD Gateway is currently underway.

This research demonstrates innovation in the development of the Logical Learning Model, which overcomes organisational challenges and provides a new perspective on influencing successful NPD practice within SMEs. Logical Learning now underpins a national business support programme where it has been applied to a range of SMEs. Furthermore, the implementation of the model has demonstrated a significant impact on NPD practice within SMEs, which has been proven through research.

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11 Appendices